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CRATAEGUS IN NORTHEASTERN ILLINOIS.

C. S. SARGENT.

THIS paper is based chiefly on the large collections and on the notes made in the neighborhood of Chicago, by Mr. E. J. Hill, of that city, during the last four years. Mr. William C. Egan, of Lake Forest, Mr. Robert Bebb, of Chicago, Mr. H. C. Skeels, of Joliet, and Mr. B. T. Gault, of Glen Ellyn, have also made important collections of Crataegus in this region. The field, however, is by no means exhausted, and there are indications in all these collections of forms which cannot now be described for want of fuller information.

CRUS-GALLI.

Stamens 10.

Anthers rose color.

CRATAEGUS PEORIENSIS Sargent, BOT. GAZ. **31**: 5. 1901; Silva N. Am. **13**: 45. *pl. 640.*

Joliet, *E. J. Hill*, June and October 1901, May and September 1902; *H. C. Skeels*, May 1902.

Anthers pale yellow.

Crataegus Arduennae, n.sp.—Glabrous. Leaves obovate, acute, acuminate or rounded at the apex, gradually narrowed from near the middle to the entire cuneate base, finely crenately serrate above, with glandular teeth; deeply tinged with red as they unfold and nearly fully grown when the flowers open; at maturity subcoriaceous, dark green and very lustrous on the upper surface, pale on the lower surface, 4.5–6^{cm} long, 1.5–3^{cm} wide, with slender yellow midribs and obscure primary veins mostly within the

parenchyma; petioles stout, grooved, winged below the middle by the decurrent base of the leaf-blades, occasionally sparingly glandular, 6–14^{mm} in length; stipules linear, dark red, minute, caducous; on vigorous shoots leaves usually elliptical, short-pointed, very coarsely serrate, usually laterally lobed, 6–7^{cm} long, 4–5^{cm} wide, with stout midribs and prominent slender primary veins, their stipules foliaceous, lunate, coarsely glandular-serrate, stalked, sometimes 1.5^{cm} in length. Flowers 1.2–1 5^{cm} in diameter on long slender pedicels, in broad thin-branched many-flowered compound corymbs; bracts and bractlets linear, minute, caducous; calyx-tube narrowly obconic, the lobes abruptly narrowed from the base, linear, acuminate, tipped with small dark red glands, entire or rarely slightly and irregularly serrate, reflexed after anthesis; stamens 5–12, usually 10; anthers small, pale yellow; styles 1 or 2. Fruit on slender pedicels, in drooping many-fruited clusters, oblong, dull dark crimson marked by large pale dots, about 1^{cm} long, 8–10^{mm} wide; calyx small, sessile, with a narrow shallow cavity and reflexed and appressed lobes; flesh thin, yellow, dry and mealy; nutlet 1, gradually narrowed from the middle to the obtuse ends, grooved and irregularly ridged on the dorsal face; or 2 and then broad, rounded at the ends, prominently ridged on the back with a high wide rounded ridge, about 8^{mm} in length.

A shrub 3–4^{m} tall with numerous erect stems and branches covered with smooth light gray bark, and slender slightly zigzag branchlets, light orange-green and marked by small pale lenticels when they first appear, dark purple and lustrous at the end of their first season, dark grayish-brown the following year, and armed with many slender straight or slightly curved dark purple shining spines 4.5–8^{cm} long. Flowers during the last week of May or early in June. Fruit ripens the middle of September.

Glen Ellyn, Du Page county, *B. F. Gault*, June 1901; rich clay loam in ravines near water or in depressions near the top of a clay hill, "Forest of Arden," Joliet, *E. J. Hill*, May and September 1902, *H. S. Skeels*, May 1902.

At Joliet Mr. H. N. Higginbotham has planned and planted a garden of three hundred acres. It is called the Forest of Arden, and here are to be brought together the trees and shrubs and other plants of the United States which can support the climate of Illinois. I am glad to adopt Mr. Hill's suggestion and associate with this thorn the name of the garden where it grows spontaneously.

PRUINOSAE.

Stamens 20.

Anthers rose color.

CRATAEGUS PRUINOSA K. Koch; Sargent, Silva N. Am. **13**:68. *pl. 648.*

Barrington, May and September 1901, Highland Park, May and October 1902, Bremen, October 1901, May 1902, *E. J. Hill;* Lake Forest, September 1901, *W. C. Egan;* Milton, DuPage county, May and September 1902, *B. T. Gault.*

Anthers pale yellow.

CRATAEGUS CONJUNCTA Sargent, Rhodora **5**: 57. 1903.

Mokena, May and October 1897, September 1898, May, September and October 1900, Highland Park, May and October 1902, Deerfield, May and September 1902, Bremen, May 1902, *E. J. Hill;* Highland Park, *W. C. Egan*, May and September 1901.

Stamens 10.

Anthers rose color.

CRATAEGUS DISSONA Sargent, Rhodora **5**: 60. 1903.

Clay banks of Lake Zurich, and adjacent oak woods, *E. J. Hill*, September 9, 1895, May and September 1899, May and October 1901, *C. S. Sargent*, September 1899; gravelly banks of Salt Creek, La Grange, *E. J. Hill*, June and September 1902.

PUNCTATAE.

CRATAEGUS PUNCTATA Jacquin.

Common.

MOLLES.

Stamens 20.

Anthers pale yellow.

CRATAEGUS MOLLIS Scheele, Sargent, Silva N. Am. **13**: 83. *pl. 659.*

Common.

CRATAEGUS SERA Sargent, Bot. Gaz. **33**: 115. 1902; Silva N. Am. **13**: 87. *pl. 661.*

Bottoms of the Desplaines and Calumet rivers, and Barrington.

Anthers rose color.

CRATAEGUS CORUSCA Sargent, Bot. Gaz. **33**: 117. 1902; Silva N. Am. **13**: 99. *pl. 667.*

Shores of Lake Zurich. Rare.

LOBULATAE.

Anthers pink or rose color.

Stamens 5–10.

Crataegus elongata, n. sp.—Leaves oblong-ovate, acuminate, rounded or concave-cuneate at the broad often unsymmetrical entire glandular base, finely doubly serrate above, with straight or incurved teeth tipped with small red glands, and very slightly divided into three or four pairs of acuminate lateral lobes; thickly coated above as they unfold with shining white hairs and villose below; more than half grown when the flowers open and then membranaceous, light yellow-green and still villose; at maturity thin but firm in texture, dark yellow-green, smooth and glabrous on the upper surface, pale yellow-green on the lower surface, 6–7 cm long, 4.5–5.5 cm wide, with stout midribs deeply impressed above and occasionally furnished with a few scattered hairs along their rose-colored base, and 5 or 6 pairs of slender primary veins extending to the points of the lobes; petioles very slender, wing-margined at the apex, slightly grooved, villose and sparingly glandular early in the season, 2.5-3 cm in length. Flowers on slender pedicels, thickly coated like the narrowly obconic tube of the calyx with long pale hairs, in very long thin-branched few-flowered villose corymbs; calyx lobes narrow, acuminate, glandular-serrate, glabrous on the outer, villose on the inner face, reflexed after anthesis; stamens five; anthers pale pink; styles 3 or 4. Fruit on elongated pubescent pedicels, in gracefully drooping few-fruited clusters, oblong-obovate, crimson, lustrous, marked by numerous small pale dots, about 1.5 cm long and 8 mm wide; calyx persistent, with a broad deep cavity and spreading and reflexed much enlarged lobes, their tips usually deciduous from the ripe fruit; flesh thick, dry and mealy; nutlets three or four, thin, gradually narrowed and acute at the apex, full and rounded at the base, ridged on the back, usually with a broad grooved ridge, 9–10 mm long.

A small tree with slender straight branchlets, dark orange-green marked by oblong pale lenticels and villose when they first appear, bright red-brown, glabrous or puberulous at the end of their first season, and dull dark gray-brown the following year, and unarmed or armed with stout, slightly curved

dark red-brown shining spines about 4.5 cm long. Flowers about the 20th of May. Fruit ripens the middle of September.

Deerfield, *William C. Egan*, May 21, 1902, *E. J. Hill*, September 10, 1902.

Well distinguished from the other described species of this group by the few-flowered corymbs, the long narrow small fruits, and the small leaves.

Crataegus sertata, n. sp.—Leaves oblong-ovate, acuminate at the apex, rounded, truncate, subcordate or rarely cuneate at the broad base, finely and often doubly serrate, with straight gland-tipped teeth, and deeply divided into five or six pairs of wide acuminate lobes; thickly coated on the upper surface when they unfold with short pale hairs and villose below along the midribs and veins, and about half-grown and villose when the flowers open; at maturity membranaceous, dark yellow-green and scabrate above, pale yellow-green and glabrous below, 6–7 cm long, 4.5–6.5 cm wide, with thin yellow midribs and slender primary veins arching obliquely to the points of the lobes; petioles slender, slightly grooved, villose early in the season, ultimately glabrous, sparingly glandular, 1.5–3 cm in length; stipules linear to lanceolate, finely glandular-serrate, caducous. Flowers 2–2.5 cm in diameter, in broad 10–15-flowered compound densely villose corymbs; bracts and bractlets linear to linear-obovate, glandular, large and conspicuous, caducous; calyx tube broadly obconic, glabrous above, villose below like the slender pedicel, the lobes abruptly narrowed from the base, broad, acuminate, tipped with small red glands, coarsely glandular-serrate, glabrate on the outer, pubescent on the inner surface, reflexed after anthesis; stamens 5–10, usually 5; anthers pale rose color; styles 3–5, surrounded at the base by tufts of pale hairs. Fruit on slender villose-pubescent pedicels, in drooping many-fruited clusters, subglobose to slightly obovate, full and rounded at the ends, bright red and lustrous, becoming darker or crimson when fully ripe, marked by occasional large pale dots, 1.1–1.5 cm long, from 1–1.4 cm wide; calyx sessile, with a broad deep cavity and enlarged mostly erect and incurved serrate lobes; flesh thin, yellow, aromatic, pleasantly acid; nutlets 3–5, usually 4, thin, narrowed and acute at the ends, slightly ridged on the back, with a wide or narrow ridge, 8 mm in length.

A tree 6–7 m in height with a trunk occasionally 2–2.5 m long and 1.5–1.8 dm in diameter, covered with close dark gray bark 6–7 mm thick, separating into long narrow thin plate-like scales, stout spreading branches forming a handsome open head, and slender nearly straight branchlets thickly coated when they first appear with matted pale hairs, light red-brown and lustrous at the end of their first season and dark gray-brown the following year, and unarmed or armed with stout nearly straight or curved spines from 2.5–6 cm long. Flowers from the 5th to the 15th of May. Fruit ripens about the middle of September and soon falls.

Open woods and pastures in rich moist soil, Barrington, May and September 1899, Mokena, September 1899, May 1900, May and September 1901, Glendon Park, May and September 1901, Lake Zurich, May and September 1901, *E. J. Hill.*

Stamens usually 20, rarely 10.

Crataegus assurgens, n. sp.—Leaves broadly ovate, acuminate, rounded or rarely cuneate at the wide entire base, sharply doubly serrate above, with straight gland-tipped teeth and slightly divided into three or four pairs of small acuminate lobes; about one-third grown when the flowers open and then roughened above by short white hairs and glabrous or sparingly villose below along the midribs and veins with persistent hairs; at maturity membranaceous, dull dark green and scabrate on the upper surface, light yellow-green on the lower surface, 7–9 cm long, 6–7 cm wide, with slender yellow midribs and thin veins arching obliquely to the points of the lobes; petioles slender, slightly grooved, villose early in the season, becoming pubescent, 2.5–4 cm in length; stipules linear to linear-obovate, acuminate, glandular, caducous; on vigorous shoots leaves often deeply lobed, very coarsely serrate, sometimes 10 cm long and wide, with long stout glandular petioles and foliaceous lunate acuminate coarsely glandular-serrate persistent stipules. Flowers 1.8–2.2 cm in diameter on short villose pedicels, in rather compact 8–15-flowered thin-branched hairy compound corymbs; bracts and bractlets oblong, acuminate, often somewhat falcate, glandular, turning brown in fading, mostly deciduous with the opening of the flowers; calyx tube narrowly obconic, sparingly villose, the lobes long, narrow acuminate, tipped with minute red glands, finely glandular-serrate, glabrous on the outer, pubescent on the

inner face, reflexed after anthesis; stamens 10–20, usually 10; anthers pinkish purple; styles 4 or 5, surrounded at the base by tufts of pale hairs. Fruit on short stout glabrous pedicels, in drooping, few-fruited clusters, oblong to slightly obovate, dull red or crimson, 1.2–1.8 ^{cm} long, 1–1.5 ^{cm} wide; calyx sessile with a broad shallow cavity and spreading closely appressed serrate usually persistent lobes; flesh thin, pale yellow or nearly white, acidulous; nutlets 4 or 5, broad, acute at the ends, prominently ridged on the back, with a high narrow ridge, or often grooved, 6–7 ^{mm} in length.

A broad much-branched shrub 2–4 ^{m} tall, or more often and in better soil a tree with an oblong head rising sometimes to the height of 8 ^{m} and forming a trunk 2–3 ^{m} long and 0.5–1.5 ^{dm} in diameter, covered with close dark gray bark; branchlets slender, light orange-yellow, marked by pale lenticels and furnished with long scattered caducous white hairs when they first appear, bright red-brown and lustrous during their first season, and dull dark gray-brown the following year, and armed with many stout usually slightly curved bright red-brown shining spines 2.5–4 ^{cm} long. Flowers the middle of May. Fruit ripens from the 15th to the 20th of September and usually falls about the 1st of October or earlier, sometimes remaining on the branches until the middle of that month.

River banks and woods in rich soil, Leyden township, May and September 1900, 1902, La Grange, June and September 1902, Thatcher's Park, May, September and October 1901, May 1902, *E. J. Hill.*

Crataegus magniflora, n. sp.— Leaves oblong-ovate, acute or acuminate, rounded or rarely cuneate at the broad entire base, coarsely doubly serrate above, with straight glandular teeth and slightly divided into numerous narrow acuminate lateral lobes; about half-grown when the flowers open and then membranaceous, light yellow-green and roughened by short white hairs and pale and glabrous below; at maturity thin but firm in texture, dark yellow-green and scabrate on the upper surface, paler on the lower surface, 6–7 ^{cm} long, 4–6 ^{cm} wide, with slender yellow midribs and thin primary veins extending obliquely to the points of the lobes; petioles slender, nearly terete, slightly grooved, puberulous early in the season, soon glabrous, 1.5–3.5 ^{cm} in length; stipules linear, acuminate, minute, bright red, caducous. Flowers 2.5–3 ^{cm} in diameter on long slender glabrous pedicels, in compact 7–10-flowered thin-branched glabrous corymbs; bracts

and bractlets linear to linear-oblong, acuminate, finely glandular-serrate, turning red before falling, mostly persistent until after the flowers open; calyx tube broadly obconic, the lobes gradually narrowed from the base, wide, acuminate, coarsely glandular-serrate, glabrous on the outer, slightly villose on the inner surface, reflexed after anthesis; stamens 20; anthers pink; styles 3–5, surrounded at the base by a narrow ring of pale tomentum. Fruit on slender rigid erect pedicels in few-fruited clusters, narrow, obovate at first when fully grown, becoming finally short-obovate to globose, full and rounded at the ends, dark crimson marked by few large pale dots, about 1.6 cm long and 1.4 cm wide; calyx sessile, with a broad shallow cavity and slightly enlarged erect and incurved lobes often deciduous from the ripe fruit; flesh thin, yellow, dry and mealy; nutlets three to five, usually four, thin, high and often gibbous in the middle, abruptly narrowed to the acute ends, usually prominently ridged, with a broad deeply grooved ridge, or rounded and slightly grooved on the back, about 8 mm long.

A bushy tree 6–7 m in height with slender nearly straight branchlets, dark orange-green and glabrous when they first appear, soon becoming dull orange or reddish brown and marked by many small pale lenticels, and darker grayish brown the following year, and slightly armed with stout straight or slightly curved dark red-brown spines about 3.5 cm in length. Flowers the middle of May. Fruit ripens from the 10th to the middle of September.

Borders of woods, in gravelly soil, Glendon Park, *E. J. Hill*, May, June, and September 1901.

Crataegus Hillii, n. sp.— Leaves oblong-ovate, acuminate, rounded or rarely cuneate at the broad entire base, coarsely doubly serrate above, with straight glandular teeth, and slightly divided into numerous short acuminate lateral lobes; when they unfold coated above with short lustrous white hairs and densely tomentose below particularly on the midribs and veins; about one-quarter grown when the flowers open and then roughened above by short hairs and still villose below; at maturity thin but firm in texture, light yellow-green and scabrate on the upper surface, pale yellow-green on the lower surface, 6–8 cm long, 5–6 cm wide, with slender midribs often slightly hairy near the

base, and 4 or 5 pairs of thin primary veins extending obliquely to the points of the lobes; petioles slender, slightly grooved, densely villose early in the season, 2.5–4 cm in length; stipules oblong, often falcate, coarsely glandular-serrate, villose, 7–8 mm long, usually persistent until the flowers have opened; on vigorous shoots leaves often truncate or slightly cordate at the base, deeply lobed with broad nearly triangular lobes, frequently 9–10 cm long and broad with stout rose-colored glandular petioles and villose lunate glandular-serrate stipules. Flowers 1.8–2 cm in diameter on slender densely villose pedicels, in broad many-flowered thin-branched hairy compound corymbs; bracts and bractlets, large, linear to oblong, acuminate, glandular with dark red glands, occasionally persistent until midsummer; calyx tube narrowly obconic, thickly covered with long spreading white hairs, the lobes abruptly narrowed at the base, broad, acuminate, coarsely glandular-serrate, glabrous on the outer, villose on the inner face; stamens 20; anthers pink; styles 4 or 5, surrounded at the base by a narrow ring of pale tomentum. Fruit drooping on slender puberulous pedicels, in few-fruited clusters, obovate, full and rounded at the apex, gradually narrowed to the rounded base, crimson, lustrous, marked by small dark dots, 1.4–1.6 cm long, 1–1.2 cm wide; calyx sessile, with a broad shallow cavity and slightly enlarged closely appressed coarsely serrate lobes often deciduous from the ripe fruit; flesh yellow, thin, acidulous, juicy; nutlets 4 or 5, thin, acute at the ends, irregularly ridged and sometimes grooved on the back, about 9 mm in length.

A tree 8 or 9 m in height with a straight trunk sometimes 2 m long and 3 dm in diameter, covered with close, light gray bark tinged with red and divided by shallow fissures into small plates, stout ascending branches forming an open irregular often round-topped head, and slender nearly straight branchlets, densely villose when they first appear, dark orange color tinged with red, marked by many oblong pale lenticels, and sparingly villose when the flowers open, bright red-brown and lustrous at the end of their first season, becoming dark dull reddish-brown the following year, and sparingly armed with slender, nearly straight red-brown shining spines 3.5–5 cm long. Flowers the middle of May. Fruit ripens from the middle to the end of September.

Open woods or near the borders of streams in moist rich soil, Thatcher's Park, September, 1899, May, August and September 1900, May and September 1901, Glendon Park, October 1900, woods by Desplaines river, River

Forest, May, June and September 1901, *E. J. Hill*; Thatcher's Park, *C. S. Sargent*, September 1900.

This species resembles *Crataegus pedicellata* Sargent, of the valley of the Genesee river in New York, but differs from it in its much more villose corymbs, stouter pedicels, more numerous stamens, and smaller obovate fruits with small closely appressed not erect and incurved calyx-lobes. This is one of the largest and handsomest thorn trees of the region and may properly help to perpetuate the name of its discoverer, Ellsworth Jerome Hill, who with unfailing energy and through many seasons has studied Crataegus in the neighborhood of Chicago.

TENUIFOLIAE.

Anthers pink or rose color.

Stamens 5–10, usually 5.

Crataegus apiomorpha, n. sp.—Leaves oblong-ovate, acuminate, rounded or rarely cuneate at the entire often unsymmetrical base, finely doubly serrate above, with slender glandular teeth and slightly divided above the middle into 4 or 5 pairs of nearly triangular acute lobes; about half-grown when the flowers open and then membranaceous, light yellow-green and tinged with red or bronze color, covered above with short white hairs and pale and glabrous below; at maturity thick and firm in texture, dark blue-green and smooth and lustrous or sometimes dull and scabrate on the upper surface, pale blue-green on the lower surface, 4–6 or on leading shoots to 8^{cm} long, 3–4^{cm} wide, with stout midribs deeply impressed on the upper side and primary veins arching obliquely to the points of the lobes; petioles slender, slightly winged at the apex, grooved, often sparingly glandular, 1.5–2.5^{cm} in length; stipules linear, acuminate, glandular, caducous. Flowers 1.2–1.8^{cm} in diameter on short villose or glabrous pedicels, in compact, many-flowered usually hairy thin branched compound corymbs; bracts and bractlets linear to oblong-obovate and rounded at the apex, finely glandular-serrate, with stipitate dark red or purple glands, large, turning red before falling, mostly persistent until after the flowers open; calyx tube narrowly obconic, glabrous, the lobes abruptly narrowed at the base, slender, acuminate, entire or sparingly glandular on the margins, reflexed after anthesis; stamens 5–10, usually 5; anthers pink; styles 3–5, surrounded at the base by tufts of pale

hairs. Fruit obovate or rarely short-oblong, bright reddish purple marked by small scattered pale dots, 1–1.6^{cm} long, 8–12^{mm} wide; calyx sessile, with a broad shallow cavity and spreading lobes, their tips mostly deciduous from the ripe fruit; flesh thin, yellow, juicy, pleasantly acid; nutlets three to five, thin, ridged on the rounded back with a low ridge, 6–8^{mm} long.

A tree 5–8^{m} in height with a trunk 1–2^{m} long and 1–2^{dm} in diameter, covered with dark gray bark separating into thin plates, 2–6^{cm} long and 1–2^{cm} wide, in falling disclosing the yellow inner bark, and dividing into several ascending branches forming an oblong or pyramidal crown resembling that of a pear tree; or often shrubby with numerous stems spreading into small clumps; ultimate branchlets rough, zigzag, covered with small twigs, dark dull red-brown and marked by small pale lenticels during their first season, dark gray-brown the following year and unarmed or armed with slender nearly straight dull red-brown ultimately ashy gray spines 3–4^{cm} long. Flowers early in May. Fruit ripens the first of September and soon falls and decays.

Dry open places, wood borders and along the margins of the high banks of streams. Common and generally distributed in the neighborhood of Chicago. Mokena, July 1900. May and September 1901, Barrington, May and September 1901, Glendon Park, May and September 1901, Tinley Park, May and September 1901, Joliet, May and September 1902, *E. J. Hill;* Joliet, *H. C. Skeels,* May 1902, Fort Sheridan, May and September 1902, *E. J. Hill.*

Crataegus cyanophylla, n. sp.— Glabrous except the upper surface of young leaves. Leaves oblong-ovate, acuminate, usually rounded or rarely truncate or cuneate at the broad base, sharply and often doubly serrate, with straight or incurved glandular teeth, and more or less divided into four or five pairs of spreading acuminate lobes; bright bronze-red when expanding; nearly half grown when the flowers open and then membranaceous, pale blue-green tinged with red and roughened on the upper surface by short pale hairs; at maturity thin, smooth, distinctly blue-green, darker on the upper than on the lower surface, 3–6^{cm} long, 2.5–5^{cm} wide, frequently as broad as long, with thin midribs and very slender prominent veins extending to the points of the lobes; petioles slender, slightly grooved, sparingly glandular, 1–3^{cm} in length; stipules linear to oblong-obovate, acute, glandular, turning pink in fading, caducous; leaves on vigorous leading shoots often elliptical, concave-cuneate at the base, long-pointed,

coarsely serrate, more deeply lobed than the leaves of fertile branchlets, 7–8 cm long, 5–6 cm wide, with stout petioles wing-margined above the middle and 2–4 cm long, and foliaceous lunate coarsely glandular-serrate persistent stipules. Flowers 1.2–1.8 cm in diameter on slender pedicels in narrow 8–12-flowered thin-branched compound corymbs; bracts and bractlets linear, glandular, mostly deciduous before the flowers open; calyx tube narrowly obconic, the lobes gradually narrowed from the base, acuminate, tipped with minute red glands, entire or occasionally slightly glandular-serrate, reflexed after anthesis; stamens 5–10, usually 5, sometimes only 2 or 3 bearing anthers; anthers small, reddish pink; styles 3–5, generally 4, surrounded at the base by tufts of white hairs. Fruit on slender pedicels, in pendent drooping few-fruited clusters, subglobose to short-oblong, slightly four-angled, abruptly rounded at the ends, dark reddish purple marked by many small pale lenticels, 1–1.6 cm long, 9–15 mm wide; calyx sessile, with a narrow shallow cavity and slightly serrate erect or incurved lobes, bright red on the upper side below the middle, usually persistent on the ripe fruit, flesh thin, yellow, firm and rather dry, insipid, slightly bitter; nutlets 3–5, usually 4, rounded at the ends, prominently ridged on the back with a broad, often grooved ridge 6–8 mm long.

A bushy or occasionally treelike shrub 3–4 m in height with slender stems covered with pale gray bark, often spreading into broad thickets, ascending branches forming an oblong head and thin nearly straight branchlets, light orange-green and marked by many small pale lenticels when they first appear, dull light reddish-brown at the end of their first season, light gray-brown the following year, and armed with numerous dull chestnut-brown ultimately gray mostly short stout curved spines tapering abruptly at the apex, and often only 1.5 cm in length, or occasionally slender and 3–3.5 cm long. Flowers during the first half of May. Fruit ripens at the end of September or early in October and does not fall until after the leaves or until the beginning of November.

Dry upland pastures on the borders of woods, Mokena, September 1899, May 1900, Bremen and Orland, October 1901, May 1902, Joliet, May and September 1902, Oak Forest, September 1902, *E. J. Hill*; Joliet, *H. C. Skeels*, May 1902.

Crataegus trachyphylla, n. sp.—Leaves oval to elliptical and acuminate, rounded or broadly cuneate, or on leading shoots

rarely subcordate at the entire base, sharply often doubly serrate above, with straight glandular teeth, and slightly divided above the middle into short acuminate spreading lobes; nearly half-grown when the flowers open and then dark blue-green tinged with red and roughened on the upper surface by short rigid white hairs and glabrous to the lower surface; at maturity very thin, dull bluish green and scabrate above, pale bluish green below, 5–6.5 cm long, 3.5–5 cm wide, often nearly as broad as long, with thin midribs and very slender primary veins extending obliquely to the points of the lobes; petioles slender, grooved, villose on the upper side early in the season, becoming glabrous, glandular, with small red stalked glands, mostly deciduous before autumn; stipules linear, acuminate, often somewhat falcate, glandular, turning reddish before falling, caducous. Flowers 1.8 cm in diameter on long slender pedicels, in broad many-flowered thin-branched compound corymbs; bracts and bractlets linear to lanceolate, glandular, turning red in fading, mostly persistent until after the flowers open; calyx tube broadly obconic, glabrous, the lobes slender, acuminate, coarsely glandular-serrate, usually only below the middle, glabrous on the outer, villose on the inner surface, reflexed after anthesis; stamens 5–7, generally 5; anthers pale pink; styles 4 or 5. Fruit drooping on long slender pedicels, in few-fruited clusters, obovate, full and rounded at the apex, gradually narrowed to the base, and often furnished on one side with a basal protuberance, crimson, lustrous, marked by small pale dots, 1.3–1.9 cm long and 1.2–1.5 cm wide; calyx sessile with a narrow shallow cavity and enlarged coarsely serrate spreading and incurved lobes bright red on the upper side below the middle, often deciduous from the ripe fruit; flesh thin, nearly white, acidulous, juicy; nutlets 4 or 5, thin, acute at the ends, irregularly ridged and often grooved on the back, about 7 mm long.

A tree 5 m in height with a trunk 2 m long and 1.5 dm in diameter covered with close dark gray bark divided by narrow fissures into numerous thin plate-like scales, ascending branches forming a narrow oblong head, and slender zigzag branchlets, dark orange color and marked by numerous small pale lenticels when they first appear, light orange-brown and very lustrous at the end of their first season, light gray-brown the following year, ultimately ashy

gray, and armed with numerous stout slightly curved light chestnut-brown shining spines 2–4 cm in length. Flowers from the 1st to the 10th of May. Fruit ripens the middle of September and soon falls.

Drift hills in clay soil, Mokena, September 26, 1900, May, June and September 1901, and May and September 1902, *E. J. Hill.*

Well distinguished in this group by the shape of the very thin scabrous leaves and pyriform fruits.

CRATAEGUS EGANI Ashe, Jour. Elisha Mitchell Sci. Soc. 17¹:15. 1900.

Bremen, October 1901; Egandale, Highland Park, May, September and October 1902; Highland Park and Tinley Park, May and September 1902, *E. J. Hill;* Mokena, September 1902, *C. S. Sargent.*

Stamens 10.

Crataegus sextilis, n. sp.—Glabrous with the exception of the hairs on the upper surface of the young leaves. Leaves short-ovate, acute, rounded, cuneate, or particularly on vigorous shoots cordate at the wide entire base, finely serrate above, with straight or incurved glandular teeth, and deeply divided into 5 or 6 pairs of spreading acuminate lobes; when they unfold deeply tinged with red, covered above with soft white hairs, and glabrous below; at maturity thin but firm in texture, dull bluish green and scabrate on the upper surface, paler on the lower surface, 3.5–4.5 cm long, 3.5–6 cm wide, and often wider than long, with slender yellow midribs and thin primary veins extending obliquely to the points of the lobes; petioles slender, often slightly wing-margined at the apex, grooved, sparingly glandular, particularly while young, from 2–3 cm in length; stipules linear to lanceolate, glandular, caducous. Flowers 1.3–1.5 cm in diameter on long slender pedicels, in compact mostly 10-flowered thin-branched glabrous compound corymbs; bracts and bractlets linear, glandular, small, usually deciduous before the flowers open; calyx tube narrowly obconic, yellow-green, the lobes narrow, acuminate, entire or slightly serrate, sparingly glandular; stamens 10; anthers pink; styles usually 3, surrounded at the base by a broad ring of pale tomentum. Fruit on slender pedicels in drooping few-fruited clusters, subglobose to short-oblong, scarlet, lustrous, 1.2–1.4 cm in diameter; calyx sessile, with a narrow shallow cavity and small spreading closely

appressed lobes usually deciduous from the ripe fruit; flesh thick, succulent, yellow; nutlets usually 3, broad, acute at the ends, very prominently ridged on the back, with a high rounded ridge, 7 mm long.

A shrub 2–3 m in height, with slender nearly straight branchlets, light yellow-green and marked by many small pale lenticels when they first appear, light red-brown and lustrous at the end of their first season, lighter-colored the following year and ultimately ashy-gray, and unarmed or armed with rather stout straight or slightly curved red-brown shining spines 1–3 cm in length; winter-buds globose covered with bright red shining scales, only 2 mm in diameter. Flowers about the middle of May. Fruit ripens from the 20th of August to the 1st of September, and immediately falls and decays.

Near Lake Zurich, September 1899, May and September 1901; Thatcher's Park, May, August and September 1900, May and August 1901; Maywood, August 1900, May and August 1901; Beverly Hills, June and August 1901, June 1902; Oak Forest, September 1902, *E. J. Hill.*

Well distinguished from the other species of this group in Illinois by the early ripening fruit which matures and drops a few days before the fruit of *Crataegus mollis* Scheele, ripens in the same region.

Crataegus paucispina, n. sp.—Leaves oblong-ovate, acuminate, rounded, concave-cuneate to truncate or subcordate at the entire base, sharply doubly serrate above, with straight glandular teeth and deeply divided into 4 or 5 pairs of acute lateral lobes spreading or pointing toward the apex of the leaf; about half-grown when the flowers open, and then light yellow-green and slightly roughened above by short white hairs and paler and glabrous below; at maturity membranaceous, dark blue-green and scabrate on the upper surface, light blue-green on the lower surface, 6–8 cm long, 4–6 cm wide, with slender yellow midribs and thin primary veins extending obliquely to the points of the lobes; petioles slender, slightly grooved, usually destitute of glands, tinged with purple in the autumn, 2–4 cm in length; stipules linear, acuminate, glandular, with large dark glands, reddish, caducous. Flowers 1.5–1.8 cm in diameter on slender pedicels covered with broad spreading hairs, in broad 12–20-flowered thin-branched slightly villose compound corymbs; bracts and bractlets linear to oblong-obovate, glandular, red, mostly persistent until after the flowers open; calyx tube narrowly obconic, glabrous, dull green, the lobes narrow,

acuminate, glandular-serrate, with small dark red stipitate glands, glabrous on the outer, pubescent on the inner face, reflexed after anthesis; stamens 10; anthers bright reddish-purple; styles 4 or 5, surrounded at the base by tufts of pale hairs. Fruit on slender glabrous pedicels in drooping clusters, pyriform to globose-pyriform, crimson or purplish, marked by many small pale dots, slightly pruinose, 1.2–1.7^{cm} long, 1.2–1.5^{cm} wide; calyx small, with an arrow deep cavity and reflexed and appressed or erect and incurved serrate lobes, dark red on the upper side below the middle, often wanting from the ripe fruit; flesh thin, yellow, juicy, acid and edible; nutlets 4 or 5, thin, acute at the ends, rounded and slightly grooved or obscurely ridged on the back, 6–7^{mm} long.

A tree 5–8^{m} in height with a trunk 1.5–2^{m} long and 1–1.5^{dm} in diameter, covered with dark gray or blackish bark, separating into thin plate-like scales, numerous branches forming a round-topped head and slender zigzag branchlets, dark yellow-green and marked by many small pale lenticels when they first appear, dark dull reddish-brown at the end of their first season, olive gray in their second year, and ultimately dark gray-brown, and armed with small straight light red-brown shining spines usually only about 1.8^{cm} in length; winter-buds subglobose to short-oblong, large and conspicuous, 3–4^{mm} in diameter, covered with dark chestnut-brown lustrous scales slightly scarious on the margins. Flowers early in May. Fruit ripens from the 8th to the 15th of September and soon falls.

Woods and river banks in dry clay soil, Maywood, September 1899, May 1900, September 1901, May and September 1902, *E. J. Hill* and *C. S. Sargent*, September 1901.

Stamens usually 20.

Crataegus tarda, n. sp.—Leaves broadly ovate, acuminate, cuneate or rounded or rarely truncate at the wide base, sharply often doubly serrate, with straight glandular teeth and divided into 4 or 5 pairs of short broad acute lobes; about half-grown when the flowers open and then membranaceous, pale green more or less tinged with red and roughened above by short pale hairs, glabrous below, at maturity thin but firm to subcoriaceous, dark bluish green and smooth or scabrate on the upper surface, pale on the lower surface, 4–7^{cm} long, 4–6^{cm} wide, sometimes broader than long, with slender prominent midribs and thin but conspicuous primary veins arching obliquely to the points of the

lobes; petioles slender, wing-margined at the apex, grooved, glandular, with numerous dark glands, mostly deciduous before autumn, 2.5–3^{cm} in length; stipules oblong-obovate rounded at the apex, glandular, tinged with red, large and conspicuous, usually persistent after the flowers open. Flowers 1.8–2.4^{cm} in diameter on slender glabrous or sparingly villose pedicels in 8–12-flowered thin-branched compound corymbs; bracts and bractlets lanceolate to oblong-obovate, acute, glandular; calyx tube broadly obconic, pale green, pubescent to glabrate, the lobes gradually narrowed from the base, wide, elongated, tipped with minute dark glands, finely glandular-serrate, glabrous on the lower, puberulous on the upper surface; stamens 10–20, usually 20; anthers pinkish purple; styles 3–5, usually 5, surrounded at the base by tuft of white hairs. Fruit on short glabrous pedicels, in compact few-fruited drooping clusters, oblong to subglobose, bright scarlet marked by numerous small pale lenticels, becoming crimson and soft and succulent when fully ripe, 1.2–1.6^{cm} long, 1.1–1.4^{cm} wide; calyx sessile, with a narrow shallow cavity and enlarged serrate spreading or erect lobes mostly deciduous from the ripe fruit; flesh thin, sweet, yellow; nutlets 3–5, usually 4 or 5, thin, acute at the ends, prominently ridged, with a thin narrow ridge or sometimes rounded and slightly grooved on the back.

A shrub 2–3^{m} in height with numerous small stems forming narrow-topped bushes, or when growing in the woods under the shade of other trees sometimes arborescent in habit with a well developed trunk and 4–5^{m} tall; branchlets stout, slightly zigzag, dark orange-green marked by many small lenticels when they first appear, bright red-brown and lustrous at the end of their first season, dark gray or gray-brown the following year, and armed with many very stout slightly curved abruptly pointed bright chestnut-colored shining ultimately gray spines 2–5^{cm} long. Flowers early in May. Fruit ripens at the end of September or early in October and remains on the branches with the leaves for another month.

Upland pastures, the borders of woods and the high banks of streams usually in hard clay soil, Barrington, June and September 1899, May 1901, Chicago Heights, May and October 1901, Orland, October 1901, May 1902, Mokena, May and September 1902, *E. J. Hill.*

Resembling superficially *Crataegus cyanophylla*, *Crataegus tarda* differs from that species in its soft succulent fruit, in its more numerous stamens, and in the usually broader and thicker light green leaves.

CRATAEGUS FERRISSI Ashe, Jour. Elisha Mitchell Sci. Soc. **17**²:11. 1901.

Highland Park, May, September and October 1902, *E. J. Hill.*

CRATAEGUS LUCORUM Sargent, BOT. GAZ. **31**:227. 1900; Silva N. Am. **13**:125. *pl. 679.*

Banks of sloughs near Barrington; Fort Sheridan, *E. J. Hill.* May and September 1902.

COCCINEAE.

Stamens 10.

Anthers pale yellow.

CRATAEGUS PRAECOQUA Sargent, Rhodora **5**:—. 1903.

Crataegus praecox Sargent, Rhodora **3**:27. 1901 (not *Crataegus Oxyacantha praecox* Loudon).

Wildwood, August 1894, May 1896, May, July and September 1899, September 1900; Barrington, May, June and September 1899; Glenwood, May, June and September 1899, May 1901; Glendon Park, May, August and September, *E. J. Hill,* 1900; Glendon Park, *C. S. Sargent,* September 1899.

Crataegus subrotundifolia, n. sp.—Leaves rhombic to broadly ovate, acute or acuminate at the apex, cuneate or rounded below, finely and often doubly serrate, with straight or incurved gland-tipped teeth, and divided above the middle into 3 or 4 pairs of short acute lobes; more than half-grown when the flowers open and then membranaceous, light yellow-green and covered on the upper surface with long white hairs and paler and glabrous on the lower surface, at maturity thin but firm in texture, glabrous, dark green and lustrous above, light yellow-green below, 3.5–4^{cm} long, 2.5–4.5^{cm} wide, often wider than long, with stout midribs and 3 or 4 pairs of prominent primary veins extending very obliquely to the points of the lobes; petioles stout, usually wing-margined to below the middle, deeply grooved, glandular with numerous dark glands mostly deciduous before autumn, often bright rose color late in the season on the lower side like that of the base of the midribs, 1–2^{cm} in length; stipules linear, glandular, reddish, caducous; on vigorous shoots leaves sometimes oblong-ovate, more deeply lobed and more coarsely serrate than on fertile branchlets, concave-cuneate below and gradually narrowed into the broadly winged petioles, 5.5–6^{cm}

long, 4–5^{cm} wide. Flowers 1.5–1.6^{cm} in diameter on long slender slightly hairy pedicels, in 7–10-flowered compact thin-branched compound corymbs; bracts and bractlets linear to oblong-obovate, acute or rounded at the apex, glandular, with large dark red glands, reddish, large and conspicuous, mostly persistent until after the flowers open; calyx tube broadly obconic, the lobes gradually narrowed from the base, wide, elongated, acuminate, glandular-serrate, with stipitate light red glands, glabrous on the outer, densely villose on the inner face, reflexed after anthesis; stamens 10; anthers pale yellow; styles 2–4, usually 3, surrounded at the base by a broad ring of pale tomentum. Fruit on slender glabrous or slightly hairy pedicels, in drooping few-fruited clusters, short-oblong, full and rounded at the ends, dark crimson, marked by many large pale dots, 1.6–1.8^{cm} long, about 1.5^{cm} wide; calyx sessile, with a broad shallow cavity and spreading serrate lobes villose on the upper side; flesh thick, yellow, dry and mealy; nutlets 2–4 broad, full and rounded at the ends, prominently ridged on the back, with a very high wide deeply grooved ridge, 7^{mm} long.

A shrub 2 to 3^{m} tall, with numerous stems spreading into small thickets, or rarely a small bushy tree 5^{m} in height, with a broad spreading top; branchlets slender, zigzag, dark orange-green and marked by oblong pale lenticels when they first appear, light red-brown and lustrous during their first season, becoming light or dark gray-brown the following year, and armed with numerous stout straight or slightly curved bright chestnut brown shining spines 2.5–5^{cm} in length. Flowers about the middle of May. Fruit ripens the first of October.

Shores of Lake Zurich, May, September and October 1901; dry woods near Honey Lake, Lake county, October 1901, *E. J. Hill.*

This addition to the COCCINEA group differs from *Crataegus coccinea rotundifolia* Sargent, of the St. Lawrence valley and the northeastern states in its thinner and usually smaller leaves villose while young on the upper surface by the villose covering on the upper side of the calyx-lobes, and by its usually smaller fruits.

TOMENTOSAE.

Stamens 20.

Anthers rose color or pink.

CRATAEGUS TOMENTOSA Linnaeus.

Common.

Crataegus vegeta, n. sp.—Leaves elliptical, acuminate, gradually narrowed and concave-cuneate at the entire base, finely often doubly serrate above, with straight glandular teeth, and slightly divided above the middle into numerous short acute lobes; nearly fully grown when the flowers open and then membranaceous, dark yellow-green and roughened above by short rigid pale hairs, and densely pubescent below; at maturity thin but firm in texture, dark dull green and scabrate on the upper surface, pale and pubescent on the lower surface along the slender midribs and 5 or 6 pairs of thin primary veins arching obliquely to the points of the lobes, 7.5–10 cm long, 4.5–6 cm wide; petioles slender, broadly wing-margined at the apex by the decurrent base of the leaf-blades, grooved, villose on the upper side early in the season, becoming glabrous and rose color in the autumn, 1.5–2 cm in length; stipules linear, acuminate, rose color, small, caducous. Flowers 1.5–1.8 cm in diameter on long slender villose pedicels, in usually 10–12-flowered thin-branched hairy compound corymbs; bracts and bractlets linear to linear-obovate, acute, glandular, becoming reddish before falling, mostly persistent until after the flowers open; calyx tube narrowly obconic, villose like the slender acuminate glandular-serrate lobes, reflexed after anthesis; stamens 20; anthers small, light pink or red; styles 2 or 3, usually 3. Fruit on slender elongated rigid slightly villose pedicels, in few-fruited erect clusters, subglobose, scarlet, lustrous, marked by small, pale dots, 9–10 mm in diameter; calyx prominent with a short tube, a narrow deep cavity, and spreading reflexed serrate lobes; flesh thin, yellow, dry and mealy; nutlets 2 or 3, full and rounded at the ends, 6 mm long and nearly as broad, prominently ridged on the back, with a high grooved ridge, the dorsal cavities broad and deep.

A tree 7-8 m in height with a tall straight trunk sometimes 2 dm in diameter, stout wide-spreading branches forming a symmetrical round-topped head, and very slender nearly straight branchlets light orange-green and marked by many large pale lenticels when they first appear, bright red-brown and lustrous at the end of their first season, darker the following year, and unarmed or sparingly armed with slender nearly straight dark purple shining spines about 4 cm in length; winter-buds ovate to subglobose, light chestnut color, lustrous, 4-5 mm long, their inner scales accrescent, bright red and very

conspicuous as the leaves unfold. Flowers at the end of May. Fruit ripens late in September.

Oak woods in moist rich soil near the bank of the Calumet river, at Calumet, *E. J. Hill*, May 27 and September 27 1901; *C. S. Sargent*, September 1901.

Crataegus Gaultii, n. sp. — Leaves elliptical to suborbicular, acute or rounded at the apex, concave-cuneate or rounded at the entire base, coarsely doubly serrate above, with straight glandular teeth, and occasionally slightly divided above the middle into short acute lobes; nearly fully grown when the flowers open and then very thin, light yellow-green and sparingly villose above, pale and slightly pubescent below; at maturity thin but firm in texture, glabrous, dark dull green on the upper surface, pale on the lower surface, 6–9^{cm} long, 5–7^{cm} wide, with stout yellow midribs deeply impressed above and 6 or 7 pairs of primary veins extending obliquely to the points of the lobes; petioles stout, wing-margined usually to below the middle by the decurrent base of the leaf-blades, villose on the upper side early in the season, with matted white hairs, becoming nearly glabrous, 1–2^{cm} long; stipules linear to linear-falcate, acuminate, glandular, with minute bright red stipitate glands, caducous. Flowers 1–5^{cm} in diameter on long slender slightly villose pedicels, in broad many-flowered thin-branched hairy compound corymbs with 3-flowered peduncles from the axils of the two upper leaves; bracts and bractlets linear, acuminate, glandular, turning red in fading, mostly persistent until the flowers open; calyx tube narrowly obconic, the lobes broad, acuminate, coarsely glandular-serrate, glabrous on the outer, villose on the inner face; stamens 18–20; anthers pale pink; styles 2 or 3. Fruit drooping on slender slightly hairy pedicels, in few-fruited clusters, subglobose to short-oblong, 1.2–1.4^{cm} in length; calyx sessile, with a broad deep cavity and spreading and appressed coarsely serrate lobes; flesh thick, yellow, soft and juicy; nutlets 2 or 3, full and rounded at the ends, about 1.2^{cm} long and nearly as wide, full and rounded on the back, with a high rounded ridge, the ventral cavities long, deep and narrow.

A tree 7–8^{m} in height with a trunk sometimes 2^{m} long and 2.5^{dm} in diameter, spreading branches forming a broad round-topped head, and slender

slightly zigzag branchlets light yellow-green when they first appear, rather light red-brown, lustrous, and marked by many large pale lenticels at the end of their first season, becoming lighter-colored the following year and unarmed or armed with occasional straight slender dark purple shining spines 3–4 cm in length. Flowers at the end of May. Fruit ripens from the middle to the end of September.

Open pastures, Milton Township, Du Page county, *B. T. Gault*, May and September 1902; Glen Ellyn, June 1902, bluff-like banks of Hickory creek, Mokena, *E. J. Hill*, October 1900, May and June 1901.

Specimens collected by Dr. Hill at Mokena have smaller and rounder leaves, glabrous on the lower surface when the flowers open but otherwise very similar to those gathered by Mr. Gault in Milton which must be considered the type of this species.

Crataegus longispina, n. sp.—Leaves ovate to rhombic, acute or acuminate, gradually narrowed and cuneate at the entire base, coarsely and doubly serrate above, with straight gland-tipped teeth, and irregularly divided above the middle into short broad acute lobes; when the flowers open membranaceous, dark yellow-green, lustrous, and covered above with soft pale hairs, lighter-colored and slightly hairy along the midribs and veins below, at maturity very thick and coriaceous, dark yellow-green, lustrous, smooth and glabrous on the upper surface, light yellow-green and still slightly pubescent on the lower surface along the thick yellow midribs and 5 or 6 pairs of slender prominent primary veins, 6–8 cm long, 4–6 cm wide; petioles stout, wing-margined at the apex by the decurrent base of the leaf-blades, grooved, villose on the upper side, becoming glabrous, usually tinged with purple in the autumn like the lower part of the midribs; stipules linear, acuminate, glandular, small, caducous. Flowers about 1.2 cm in diameter on very long slender slightly hairy pedicels, in broad many-flowered thin branched villose compound corymbs; bracts and bractlets linear to linear-obovate, acuminate, elongated glandular with minute dark red stipitate glands, conspicuous, generally persistent until the flowers open; calyx tube narrowly obconic, villose toward the base, glabrous above, the lobes narrow, acuminate, coarsely glandular-serrate, glabrous on the outer, sparingly villose on the inner surface; stamens 20; anthers pale pink; styles 2 or 3. Fruit on stout glabrous red pedicels, in large many-fruited drooping clusters, subglobose,

usually slightly wider than high, scarlet, lustrous, marked by few small dots 8–10^{mm} in diameter; calyx prominent, nearly sessile, with a narrow deep cavity and enlarged coarsely serrate reflexed and closely appressed lobes villose on the upper side, and usually persistent on the ripe fruit; flesh thin, yellow, dry and mealy, not becoming succulent; nutlets 2 or 3, full and rounded at the ends, 6^{mm} long, 7^{mm} wide, rounded and prominently grooved on the back, with a wide doubly grooved ridge, the ventral cavities broad and deep.

A shrub 1–2^{m} in height with stout branchlets, dark reddish-brown and marked by large pale lenticels when they first appear, light red-brown and very lustrous at the end of their first season, rather darker-colored and still lustrous the following year, and armed with numerous very stout nearly straight dark purple shining spines 6–9^{cm} long.

Sandy shores of Lake Zurich, *Hill* and *Sargent*, September 22, 1900, *E. J. Hill*, May and October 1901.

Crataegus rutila, n. sp.—Leaves broadly ovate to oval or suborbicular, rounded or abruptly narrowed and acute at the apex, rounded, concave-cuneate or rarely slightly cordate at the wide entire base, sharply and doubly serrate above, with straight glandular teeth, and divided above the middle into numerous small acuminate lobes; more than half-grown when the flowers open and then membranaceous, dark yellow-green, very smooth and glabrous above with the exception of numerous short white deciduous hairs on the upper side of the midribs, and pale and slightly pubescent or nearly glabrous below; at maturity subcoriaceous, dark yellow-green on the upper surface, light yellow and glabrous or puberulous on the lower surface, 4.5–7.5^{cm} long, 4.5–6.5^{cm} wide, with very stout yellow midribs deeply impressed above, 5 or 6 pairs of prominent primary veins, and thick conspicuous reticulate veinlets; petioles stout, wing-margined often to the middle by the decurrent base of the leaf-blades, covered on the upper side early in the season with short soft hairs, becoming glabrous, often tinged with purple in the autumn, 1–2.5^{cm} in length; stipules linear, acuminate, glandular, with small stipitate red glands, caducous. Flowers about 1.5^{cm} in diameter on long slender sparingly villose pedicels, in broad compact many-flowered thin-branched nearly glabrous compound

corymbs; bracts and bractlets linear to oblong-ovate, acuminate, glandular and usually persistent until after the flowers open; calyx tube broadly obconic, glabrous, the lobes wide, acuminate coarsely glandular-serrate, glabrous on the outer, villose on the inner surface, reflexed after anthesis; stamens 20; anthers pink; styles 2 or 3, usually 2, surrounded at the base by small tufts of white hairs. Fruit drooping on slender glabrous pedicels, in few or many-fruited clusters, subglobose, orange-red, marked by occasional large pale dots, becoming crimson and lustrous when fully ripe, 8–10^{mm} in diameter; calyx prominent with a broad deep cavity and spreading and closely appressed lobes; flesh thin, yellow, soft and succulent; nuts usually 2, full and rounded at the ends, 6–7^{mm} long, often 5^{mm} wide, prominently ridged on the back, with a broad deeply grooved ridge, the ventral cavities very oblique, broad and deep.

A shrub or small tree sometimes flowering when not more than 1^{m} in height, with rather stout nearly straight branchlets, light orange-green and marked by small pale lenticels when they first appear, bright reddish brown and lustrous at the end of their first season, dark reddish brown the following year, and unarmed or armed with occasional stout nearly straight dark purple shining spines about 2.5^{cm} in length. Flowers from the 20th to the end of May. Fruit ripens from the first to the middle of October.

Pastures, Mokena, September and October 1900, May and June 1901, bluff bank of Thorn creek, Chicago Heights, May and October 1901, *E. J. Hill*; shores of Lake Zurich, *C. S. Sargent*, September 1900; Milton Township, Du Page county, *B. T. Gault*, May and September 1902.

Anthers pale yellow.

Crataegus laxiflora, n. sp.— Leaves obovate to ovate-oblong on leading shoots, acuminate, acute or broad and rounded at the apex, mostly gradually narrowed from near the middle to the rounded or cuneate entire base, sharply and doubly serrate above, with straight gland-tipped teeth, and divided toward the apex into 3 or 4 pairs of short acute lobes: about half-grown when the flowers open and then membranaceous, dark yellow-green, lustrous, smooth and glabrous with the exception of a few deciduous hairs near the base of the midrib on the upper surface, light yellow-green and glabrous on the lower surface; at maturity coriaceous, dark green and very lustrous

above, light yellow-green below, 4–7^{cm} long, 3–4^{cm} wide, with stout yellow midribs and thin prominent primary veins extending obliquely to the points of the lobes; petioles stout, grooved, slightly wing-margined at the apex, pubescent on the upper side early in the season, soon glabrous, often tinged with red in the autumn, 1.5–2^{cm} in length. Flowers about 1^{cm} in diameter on long slender pedicels, in broad many-flowered thin-branched very lax villose compound corymbs; bracts and bractlets oblong-obovate to linear, acuminate, glandular, turning red in fading, generally deciduous before the flowers open; calyx tube narrowly obconic, thickly covered with long matted or spreading white hairs, the lobes broad, acuminate, coarsely glandular-serrate, with minute bright red stipitate glands, glabrous on the outer, slightly villose on the inner surface, reflexed after anthesis; stamens 18–20; anthers small, pale yellow; styles 2. Fruit on elongated slender glabrous pedicels, in long many-fruited gracefully drooping clusters, subglobose to short-oblong, bright orange-red, lustrous, marked by occasional large pale lenticels, about 8^{mm} in diameter; cavity of the calyx deep and narrow, the lobes early deciduous, leaving a ring-like border to the long tube; flesh thin, yellow, sweet, dry and mealy, hardly becoming soft and succulent; nutlets 2, full and rounded at the ends, 6^{mm} long, 5–6^{mm} wide, prominently grooved on the back, with a wide doubly grooved ridge; ventral cavities very broad and deep, extending nearly the entire length of the nutlet.

A small tree 3–8^{m} high, with slender slightly zigzag branchlets, light orange-green and glabrous when they first appear, bright red-brown, very lustrous and marked by occasional small dark lenticels at the end of their first season, becoming darker the following year, and armed with numerous slender straight bright purple shining spines 3–4^{cm} in length. Flowers during the last week of May. Fruit ripens the middle of October.

Banks of the north branch of Hickory Creek at Marley, September 1895, May and October 1897; upland pastures, Mokena, September and October 1900, May and September 1901, *E. J. Hill.*

Stamens 10 or fewer.

Anthers pink.

Crataegus divida, n. sp.— Leaves oblong-ovate, concave-cuneate or rounded at the gradually narrowed entire base,

coarsely doubly serrate above, with straight gland-tipped teeth, and very slightly and irregularly divided above the middle into small acute lobes; more than half-grown when the flowers open and then dark green and roughened above by shining white hairs, and paler and glabrous below; at maturity thin but firm in texture, light bluish-green and scabrate on the upper surface, pale on the lower surface, 5.5–8^{cm} long, 4.5–5.5^{cm} wide, with slender yellow midribs deeply impressed on the upper side, and 5 or 6 pairs of thin primary veins extending very obliquely to the points of the lobes; petioles stout, wing-margined at the apex, grooved, sparingly villose early in the season, becoming glabrous and dark purple, glandular with minute scattered dark glands, 2.5–3^{cm} in length. Flowers 1.5–2^{cm} in diameter on long slender pedicels, in broad many-flowered thin-branched glabrous compound corymbs; bracts and bractlets linear, acuminate, slightly glandular, reddish, mostly deciduous before the flowers open; calyx tube broadly obconic, glabrous, the lobes abruptly narrowed at the base, wide, acuminate, tipped with minute red glands, coarsely glandular-serrate, glabrous on the outer and villose on the inner face; stamens 5–10; anthers pink; styles 2 or 3. Fruit on glabrous red pedicels in drooping few-fruited clusters, short-oblong to subglobose, crimson, lustrous, marked by small pale lenticels, 1–1.2^{cm} in diameter; calyx prominent with a broad deep cavity and much enlarged coarsely serrate spreading lobes, dark red on the upper side below the middle, slightly villose toward the apex, generally persistent on the ripe fruit; flesh thin, yellow, soft and succulent; nutlets 2 or 3, full and rounded at the ends, 7^{mm} long, 6^{mm} wide, prominently ridged on the back, with a broad high deeply grooved ridge, the ventral cavities broad and shallow.

A small round-headed tree, 4–5^{m} in height, with slender nearly straight branchlets, light orange-green and marked by small pale lenticels when they first appear, light reddish-brown and very lustrous at the end of their first season, and gray or light reddish-brown the following year, and armed with few very stout slightly curved bright chestnut-brown shining spines 3.5–4^{cm} long. Flowers about May 20th. Fruit ripens early in October, but is apt to wither on the tree.

Borders of woods on clay hills near Barrington, May, June and Septem-

ber 1899, Barrington village, May, June and September 1899, and May and October 1901, *E. J. Hill.*

Anthers light yellow.

Crataegus corporea, n. sp.—Leaves rhombic, acute at the apex, concave-cuneate at the entire base, finely serrate above, with straight gland-tipped teeth and usually slightly divided above the middle into several short broad acute lobes, about half-grown when the flowers open and then membranaceous, dark yellow-green and sparingly villose above, pale and glabrous below; at maturity subcoriaceous, glabrous, smooth and dark bluish green on the upper surface, light yellow-green on the lower surface, 5–7 cm long, 4.5–6 cm wide, with stout yellow midribs deeply impressed on the upper side and five or six pairs of prominent primary veins; petioles stout, wing-margined toward the apex, deeply grooved, slightly villose on the upper side early in the season, soon glabrous, 1–1.8 cm in length. Flowers 1.5 cm in diameter on long slender pedicels, in broad many-flowered thin-branched slighly villose compound corymbs; bracts and bractlets linear, acuminate, glandular, mostly deciduous before the flowers open; calyx tube broadly obconic, glabrous, the lobes wide, acuminate, coarsely glandular-serrate, with small stipitate bright red glands, glabrous on the outer, villose on the inner face, reflexed after anthesis; stamens 5–10; anthers pale yellow, surrounded at the base by small tufts of pale hairs. Fruit on stout dark red glabrous pedicels in many-fruited drooping clusters, subglobose, dark reddish purple, lustrous, marked by occasional pale dots, becoming very soft and succulent when fully ripe, and 1.5–2 cm in diameter; calyx prominent, with a broad deep cavity and spreading and closely appressed lobes villose and dark red on the upper side, often deciduous from the ripe fruit; flesh thick, yellow, sweet and juicy; nutlets 2 or 3, full and rounded at the ends, about 7 mm long and 6 mm wide, ridged on the rounded back, with a low wide ridge, the ventral cavities short and deep.

A shrub with slender stems 1–2 m in height, spreading into small thickets, and stout slightly zigzag branchlets light reddish-brown and marked by large pale lenticels when they first appear, light red-brown and very lustrous at

the end of their first season, darker and still lustrous the following year, and ultimately gray tinged with red, and armed with stout nearly straight dark purple shining spines 7–9^{cm} long. Flowers from the 20th to the end of May. Fruit ripens at the end of September.

Gravelly shores of Lake Zurich, *Hill* and *Sargent*, September 22, 1900; *E. J. Hill*, May and September 1901.

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MITOSIS OF THE PRIMARY NUCLEUS IN SYNCHYTRIUM DECIPIENS.

FRANK LINCOLN STEVENS and ADELINE CHAPMAN STEVENS.

(WITH PLATES XVI AND XVII)

THE fungus *Synchytrium decipiens* Farlow invades single cells of the hog peanut (*Falcata comosa* (L.) Kuntze) and there causes proliferation of the tissue until the host cell is imbedded in a gall of considerable size. The parasite is at first seen resting in the cytoplasm of the host cell and occupying it conjointly with the host nucleus of that cell. The parasite, growing more rapidly than the host cell in the early stage of its enlargement, soon comes to occupy the whole cell space, while the host nucleus slowly disappears. During further gall growth the parasitized cell becomes many times larger than when attacked. The cytoplasm of the parasite increases *pari passu*, continuing to fill completely the host cell. Increase in cytoplasm is accompanied by a corresponding growth of the Synchytrium nucleus. It thus happens that while the nucleus of the invading Synchytrium was at first very small, it later reaches proportions vastly larger than the nucleus of the host plant, larger even than the notoriously large nuclei found elsewhere in the plant kingdom. The maximum diameter of the embryo sac nuclei of flowering plants ranges in the neighborhood of 20–30 μ and that of the vegetative nuclei from 5 to 9 μ. The nucleus of this unicellular fungus parasite often attains a diameter of 35 μ, with a nucleolus 11 μ or more in diameter.

The vegetative period of the parasite is characterized by increase in size of both the fungus body and its nucleus. This period may be said to end and the reproductive period to begin with those processes which lead to separation of this mass of cytoplasm into numerous portions which are by further division to become swarm spores. The first step toward the separation of the cytoplasmic body is the division of this primary nucleus.

This process is of peculiar interest because of the large size of the nucleus, quite exceptional among the fungi, its peculiar rapid growth and subsequent division, and the problematic taxonomic position of the Chytridiales, which we may reasonably hope will be cleared up by cytological research. The very few investigations already published on species of this genus in no way detract from the interest of the problem. Two investigators, Dangeard ('90) and Rosén ('93), have reported results from *Synchytrium Taraxaci* DeB. & Wor., which, though not agreeing in detail, reveal conditions entirely unique. They are of such a nature as to demand further investigation and if possible reconciliation with current theories of the nucleus, which suffer violence if the conditions imperfectly reported by these authors really exist. Dangeard employed modern technique, although absolute alcohol and haematoxylin, his favorite fixative and stain, do not seem to be adapted to critical research in this group.

Dangeard describes the nuclear membrane of *Synchytrium Taraxaci* as granular, the nucleolus also being granular and quite spherical. He says that the nucleus divides by successive bipartition, a method of direct division. The membrane inflexes and the daughter nuclei become separated by constriction of the parent nucleus. He figures such division, showing two daughter nuclei together with their clumped chromatin masses grouped on adjacent sides, the parent chromatin group being evidently constricted, as is the remainder of the nucleus. Aside from this curious method of direct division, Dangeard states that the nucleus sometimes divides indirectly, and his *fig. 23* shows what he considers to be a type of mitosis. From both his text and figures it appears that this mitosis occurs in divisions later than the primary, and that both mitosis and direct division may occur side by side in the same cytoplasm, thus presenting a very unique condition, since it is usual in multinucleate masses of cytoplasm for the nuclei to divide not only by the same mode but also almost simultaneously. Dangeard does not claim to have followed the mitosis in Synchytrium through its phases, but he mentions it rather incidentally as a mode seen but not followed in edtail.

Rosén ('93) touched lightly upon *Synchytrium Taraxaci*, and his results agree with those of Dangeard to the extent that he describes a direct division in the primary nucleus. This division however is so different in type from that described by Dangeard that it certainly could not have been described or figured from the same structures. In the primary nucleus Rosén finds that the chromatin loops into a spirem, the nucleolus divides, the halves migrating to the forming daughter nucleus. The nucleus then constricts in the middle, thus completing a division of the nucleus in its spirem condition without the aid of the usual achromatic structures. He asserts that as successive divisions follow they assume more and more the character of mitosis, eventually presenting a typically mitotic division.

While discrepancies exist between these two authors regarding the details of the amitosis, they agree that mitosis is the exception and amitosis the rule; also that the primary division, *i. e.*, the first division of the one primitive nucleus of each sorus, is a direct division.

The present investigations have been exclusively concerned with *S. decipiens* Farl., and our results are directly comparable therefore with those of Dangeard and Rosén only in so far as different species of one genus may be expected to agree in cytological detail. However, the work on Fucus (Oltmanns, '89) and Albugo (Stevens, '99, '01) shows more specific cytological variation than *a priori* judgment would admit.

The caption of the present article, indicating that the primary division is mitotic, emphasizes one of the chief features of divergence between these results and those of Dangeard and Rosén. We may here indicate also that in affirming that the primary division may be mitotic we in no way set aside the possibility of its being sometimes, even frequently, amitotic. There are many peculiar structures to be found in the sori of Synchytrium, which it seems impossible to reconcile with universal mitotic division. A consideration of these leads to conclusions at variance again with those of Dangeard and Rosén regarding the details of the amitotic division. Discussion of these structures is reserved for a separate paper, the present one being lim-

ited to a description of a series of stages, all clearly pertaining to true mitosis in the primary nucleus.

De Bary and Woronin observed and have described in beautiful detail the entrance of Synchytrium into the host cell. From this point it is easy to follow the cytological changes. The cytoplasm of the invading parasite stains deeply, and is clearly recognized imbedded in the lighter cytoplasm of the host cell. For some time both the nucleus and the cytoplasm of the host cell persist, but eventually they disappear, the parasite in the meantime increasing rapidly in size. A moderately early stage of development is represented in *fig.* 1, which shows the granular, darkly staining mass of cytoplasm, spherical in form, and with a relatively large nucleus and nucleolus. Adjacent host cells exhibit nuclei and chloroplasts, thus admitting of comparison as to their relative size. At this and other early periods of development the nucleolus is large, usually solitary, homogenous in appearance, and surrounded by a thick darkly staining wall which is probably largely composed of a layer of linin laden with chromatin. Encasing the nucleolus is a mass of chromatin usually forming a continuous covering, and in places collected into irregular heaps and lumps. Occasional strands of chromatin connect the nucleolus, which is usually centrally placed, with the nuclear membrane. Chromatin is also found distributed in apparently disconnected globules of varying size, studded thickly over the inner surface of the nuclear membrane.

The parasite rapidly enlarges to occupy completely the host cell, which soon becomes enormous in size as gall-formation proceeds. A single host cell which normally averages less than 15 μ in diameter after occupation by the parasite usually attains a diameter of 100 μ or more. As the cell grows the nucleus grows, reaching at its maximum a diameter of 35 μ. During this enlargement the character or structure of the nucleus changes somewhat. The nuclear membrane becomes thicker and more conspicuous. The globules of chromatin studding its inner surface increase in number and size, and more connections are established between the chromatin surrounding the nucleolus and that of the periphery.

The nucleolus follows the growth of the nucleus, enlarging to a diameter of about 14 μ. Nucleolar inclusions in the form of homogenous globules of varying size imbedded in a granular matrix are more abundant than in earlier stages. A single cell of Synchytrium divested of its host envelope is exhibited in *fig. 2*. The nucleus has not yet reached full size, but is typical of this stage of development. It shows well the thick nuclear membrane, the peripheral chromatin, the connecting strands, and the nucleolar inclusions. *Fig. 3* shows a single more mature nucleus drawn to a larger scale. Here the chromatin is arranged in lumps, massed largely on one side of the nucleolus, while the inside of the wall is thickly beset with chromatin-bearing globules. The nucleolus is still more granular and the inclosed globules more numerous than in earlier stages. The whole dark central portion of the nucleolus must be interpreted as a vacuole, which, together with the increasing number and size of imbedded globules (dissolution products), indicates the disintegration of the nucleolus, a change further emphasized in *fig. 4*, where the nucleolus is almost entirely converted into the characteristic vacuoles. This change in the nucleus is the first visible sign of approaching mitosis. In the stages represented in *figs. 1, 2, 3, 4*, a large and remarkably clear area may be seen between the nucleolus and nuclear membrane, evidently a large vacuole created by the characteristic aggregation of the chromatin.

Up to this time the nuclear membrane has been sharp and distinct, even thick, the nucleolus large and conspicuous, the chromatin in irregular masses partaking in no way of the appearance of threads, and a large intranuclear vacuole has been constantly present.

All of this now changes. The membrane becomes gelatinous, the chromatin assumes a spirem form, and the nucleolus disappears. The nuclear membrane, previously thick and definite, first loses sharpness on its outer surface and is no longer to be seen as a definite wall. Dissolution begins from the outside. The nuclear region is long maintained, clearly mapped out, being now bounded by a layer of gelatinous consistency which stains more darkly with the orange G than does the surrounding

cytoplasm. The replacement of the nuclear wall by this gelatinous substance is a process which can be followed closely from its inception (*fig. 5*) to the later stages of mitosis (*fig. 14*). The inner boundary of the nuclear wall remains definite until mitosis is well advanced (*fig. 10*). The first indication of the dissolution of the nuclear wall is evidenced by the darker staining of the cytoplasm immediately in contact with the wall (*fig. 4*). This darkly stained region rapidly grows to a layer of gelatinous consistency in which the cytoplasm is of finer mesh and tends to be more granular. Changes very similar to those noted accompany both dissolution and building up of walls in Albugo (Stevens, '99). As the character of the nuclear membrane changes a marked shrinkage in the size of the nucleus occurs, possibly directly induced by the altered osmotic relations. A decrease from 40 to 20 μ is not unusual in this first step toward mitosis. The nucleolus, dissolution of which had proceeded far in *fig. 3*, now completely disappears. The line bounding it, which seemed a husk of chromatin rather than a definite membrane, vanishes, and the nucleolar substance, which was much wasted by the one large and many small vacuoles, is no longer to be seen. Occasional small globules, staining like vacuoles of the nucleolus (*fig. 3*), may be found in the spirem and constitute the only remaining trace of the nucleolus (*fig. 7*).

The chromatin undergoes a change as striking as that of the membrane and nucleolus. Formerly coarse and lumpy (*fig. 3*), its globular masses become much more numerous and relatively smaller (*fig. 5*). They then appear to elongate, the numerous globules being replaced by rods crossed and tangled in inextricable confusion. *Fig. 6* represents a condition where the globules have partially changed to the elongate form, while *fig. 7* shows the completion of this phase, resulting in what must be regarded as the typical spirem of this primary division in *Synchytrium decipiens*. It is characterized by fine even threads of chromatin, uniformly distributed throughout the nucleus, yet tangled and intertwined in a most complicated way. The dots in the figure represent end views of the chromatin threads, and the lines the same from a side view. The slightest change in focus brings

many others to view. It is particularly noticeable that no curving or looping is seen, the threads ever remaining straight and intersecting in acute angles.

Judging merely from the size of the nuclei, the critic may assert that *fig. 7* represents a stage intermediate between those of *figs. 1* and *3*, a criticism that is fully met, however, by further study of the figures, since neither the condition of the nuclear membrane nor of the nucleolus admits of the intercalation of any such condition as that shown in *fig. 7*. Moreover, the sorus is at its maximum when presenting the structure shown in *fig. 7*, which would not be the case if this were intermediate between *figs. 1* and *3*. Even if no more advanced stages were discovered, we see no escape from the conclusion that *fig. 7* represents the spirem and is a later development from such structures as are shown in *figs. 1, 2, 3*, etc. The fact that *fig. 6* is slightly smaller than *fig. 7* is explicable by the assumption that it is derived from a smaller resting nucleus. *Fig. 6* clearly represents a stage early in the dissolution of the nuclear membrane, likewise early in spirem formation. It must lie between *figs. 5* and *7*, and that without contradicting the general fact of a nuclear shrinkage throughout the mitosis. *Figs. 8–10* represent a progressive series of stages clearly more advanced than *figs. 4–6*. In these the boundary region is practically unchanged in character, though continually contracting with the diminution of the nucleus. The spirem threads as shown in *fig. 8* become slightly thickened, apparently by longitudinal fusion of separate rods. There is a tendency of the chromatin to accumulate in masses, though never partaking of that peculiar characteristic lumpy appearance shown in *figs. 3, 4*. Vestiges of the nucleolus remain as in *fig. 7* throughout further stages of mitosis. *Fig. 9* shows, in a much more pronounced way, how the threads coalesce as they meet in the center. Meanwhile the size of the nucleus decreases. In *fig. 10* there is a distinct indication of an arrangement in spindle form, though many strands remain as yet apparently in no way connected with the developing spindle. From this series and numerous other similar stages seen by the writers, there remains no doubt that from the spirem the nucleus passes to a definite

spindle formation. This spindle is intranuclear, thus agreeing with the nuclei of fungi generally. However, it is usual in the intranuclear formation of the spindle for the poles to originate in contact with the nuclear membrane, whereas in this case they are far from being so placed. As to the exact mode of spindle formation we can say nothing further than that the threads of the spirem group form themselves into a spindle. No centrosomes or polar radiations were distinguished in any stages of the mitosis.

During progress from the condition shown in *fig. 3* to that of *fig. 10*, a striking and remarkable change has occurred, in that the whole chromatin content has decreased largely. *Figs. 12* and *14* show a still greater reduction. All of the chromatin-bearing parts diminish, until, as in *fig. 11*, only a well marked spindle remains, bearing a few short chromosomes. In all early stages there seems to be a vast quantity of chromatin distributed at first throughout these globules, and later (*fig. 7*) on a linin network of large extent, while after the formation of the spindle the chromatin is insignificant in amount. There is here either a great condensation or an actual reduction in the amount of chromatin. Increase in the density of staining favors the former view, although the decrease in volume is too great to be attributed wholly to such a cause.

The nuclear membrane is gelatinized as early as the conditions shown in *figs. 5* and *6*. With the constant shrinkage of the nucleus it decreases in superficial area, but apparently not in volume, inasmuch as it constantly grows in thickness. Eventually the spindle, by the constant shrinkage of the gelatinous membrane, comes to lie in a narrow court surrounded by a broad dense zone of granular substance staining strongly with the orange G. This halo, clearly the residue of the altered nuclear membrane, is a conspicuous object in the field, though the nucleus itself is now very small, averaging 10 μ or less in length. The nucleolus persists unchanged in character from the condition shown in *fig. 10*, *i. e.*, it is similar to the nuclear vacuole shown in *fig. 3*.

A distinct view, slightly after metaphase, is given in *fig. 12*,

showing the chromosomes at the two ends of the spindle. They are probably four in number, although we do not assert this with certainty. After the polar migration of the chromosomes the whole spindle lengthens much, giving a peculiar distorted figure similar to that found in the nuclei of *A. Bliti*, and the telophase is of similar nature to that described for that fungus (Stevens, '99). The spindle fibers fall together in the center and divide, giving rise to the independent daughter nuclei.

This mitosis agrees well in late anaphase with that of many other fungi, conspicuously so with Albugo. In many other respects it is unique. The early dissolution of the membrane and the persistence of its remains as a granular halo around the metaphase and anaphase figures is a new phenomenon, as is also the mode of spindle formation. The spirem also differs from any previously described, and the behavior of the nucleolus is unique; while the disposition of the chromatin in resting and early prophase conditions is exceptional.

The great size of the nucleus led to an inference that the mitosis would present, perhaps more clearly than any other type of fungus, the details of spindle formation. This inference was unfounded, since the shrinkage of the nucleus preparatory to mitosis reduces the spindle to moderate dimensions. Moreover the stages are rare to find. Hundreds of samples were examined showing no trace of mitosis, while a very few leaves of the host plant were found exhibiting good stages. When a block of good material is secured it gives abundant cases, however, to prove the existence of mitosis. Still, as there can be obviously only one primary division in each sorus it is an exceedingly slow task to complete a series. All of the figures represented come from sori bearing only one nucleus, and unquestionably represent primary division. Occasional views of the second and succeeding mitosis were had, but here the subject becomes much complicated and discussion is reserved for a later paper.

The significance of the facts observed, such as the enlargement of the nucleus and its subsequent shrinkage, the peculiarities of mitosis, the chromatin changes, etc., will be better interpreted when the other peculiarities in the cytology of this

fungus are described. The Chytridiales have offered an open field for speculation heretofore, and have baffled definite judgment as to their nature and relationship. Fuller knowledge of their cytological peculiarities may lead to a more satisfactory condition.

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EXPLANATION OF PLATES XVI AND XVII.

All figures are from material killed in chrom-acetic acid and stained with Flemming's triple stain. The figures were sketched with an Abbé camera, using a Leitz $\frac{1}{12}$, ap. 1.30, giving an enlargement of 1790 diameters, with the exceptions of *figs. 1* and *2*, which were drawn from a Bausch and Lomb $\frac{1}{6}$, with a magnification of 750 diameters. Plate not reduced in reproduction.

PLATE XVI.

FIG. 1. One parasitized cell in early stage of development, showing large nucleus and nucleolus surrounded by granular cytoplasm; adjacent cells show nuclei and chloroplasts.

FIG. 2. Parasite nearly at end of growing period; nucleus heavy walled, vacuolate; chromatin distributed along nuclear wall, around the nucleolus, and on connecting strands.

FIG. 3. Single nucleus of a stage similar to but slightly later than *fig. 2*, and more highly magnified; nuclear vacuoles prominent, nucleolar substance giving way to vacuoles; chromatin on nuclear wall also arranged in irregular heaps around the nucleus; nuclear wall still definite and firm.

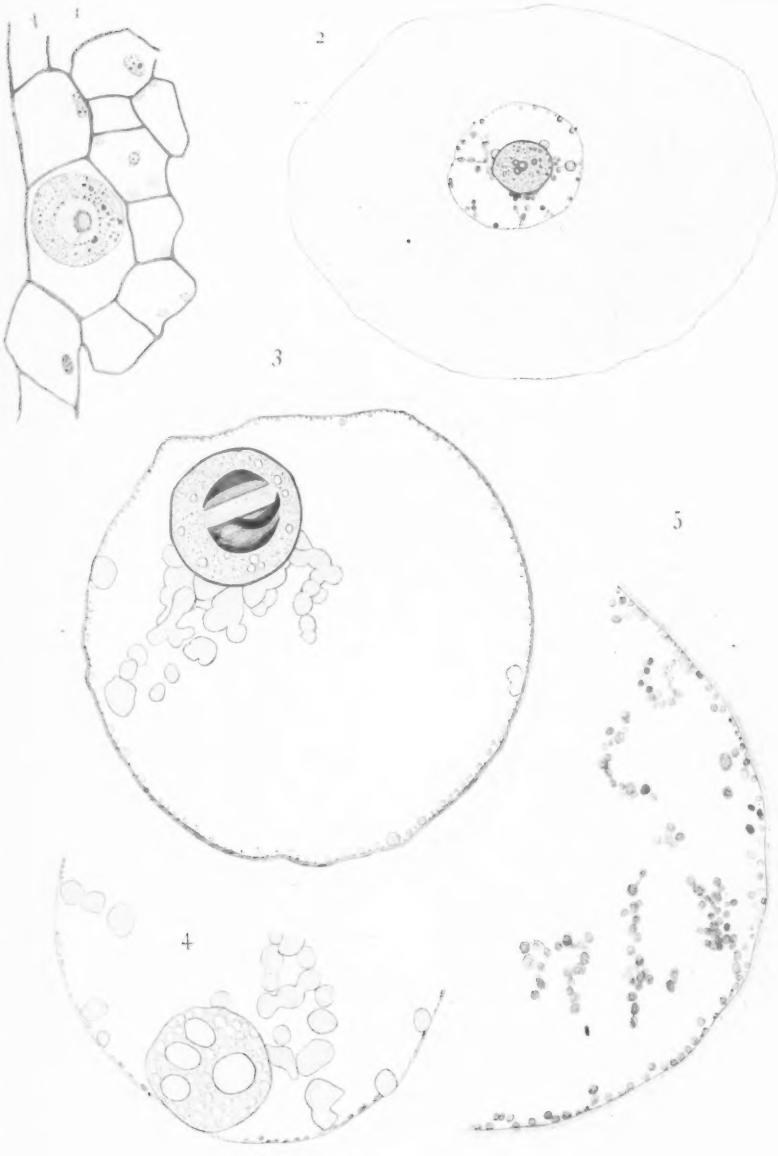
FIG. 4. Portion of nucleus slightly later, showing the continued wasting of the nucleolus and a somewhat more even distribution of chromatin.

FIG. 5. Portions of nucleus still later; nucleolus not present; the large chromatin lumps and globules of *fig. 4* have given place to more numerous and smaller ones which have also taken on a much more even distribution, thus largely obliterating the large conspicuous vacuole of earlier stages; the nuclear membrane is less distinct on its outer border.

PLATE XVII.

FIG. 6. The chromatin globules of earlier figures are assuming the rod-form; the nuclear membrane has softened from the outside inward, being now largely represented by a thick layer which stains darkly with the orange G.

FIG. 7. Chromatin rods entirely replace the globules of earlier stages; these rods intersect at sharp angles, often appearing as dots from end view; a nucleolus, similar in stain to the nucleolar vacuoles in *fig. 4*, is seen to the



Lith. Anst. v. E. A. Funke, Leipzig.

STEVENS on SYNCHYTRIUM

6

7

8

11

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14

left; a shrinkage in the size of the nucleus is marked in passing from *fig. 3* to *figs. 6–7* and succeeding figures.

FIG. 8–9. The linin commences to aggregate near the center of the nucleus; shrinkage continues and dissolution of the membrane proceeds.

FIG. 10. Linin threads assume spindle form; shrinkage continues and with it increase in the thickness of the layer bounding the nucleus.

FIG. 11. Well defined spindle surrounded by residue of the membrane, now a mass of substance staining densely with the orange G; chromosomes near equator and several nucleoli present.

FIG. 12. Chromosomes passing toward poles.

FIG. 13. Chromosomes at the poles.

FIG. 14. Constriction of the nuclear spindle at the equator preparatory to final separation of the daughter nuclei.

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THE MACCHIE OF THE NEAPOLITAN COAST REGION.

J. Y. Bergen.

(*Continued from p. 362.*)

CLIMATIC ENVIRONMENT. ADAPTATIONS TO CONDITIONS.

The general character of the Neapolitan climate, with its mild moist winters and long dry summers, has been mentioned in a previous article. The irregular distribution of the mountains along the coast of the Bay of Naples and upon its islands produces considerable inequalities in the rainfall of localities not widely separated.

In Capri, during the summer in which I was engaged in studying its flora (1902), the precipitation was less than usual, 45 mm in May, ending on the twentieth, and then a rainless period of four months, except for a shower of 6 mm on September 13. During a more nearly average year (1901) the precipitation for May was 179 mm, June and July 56.5 mm, August none, and September 97.2 mm.

During the three hot, dry months (June, July, August), the nights are usually moderately cool. In 1902 the minimum for the three months was 10.8° C. The maximum for the same period, measured under strictly standard conditions, was 31.9° C. The average of daily maximum temperatures for June, July, and August was 26.4° C. It is noteworthy that the heat is continuous, the maximum of each day usually differing less than 2° from that of the day before or the following day. The desiccating effect of hot air upon vegetation is, of course, largely dependent upon the relative humidity of the atmosphere. During June, July, and August, 1902, the relative humidity at 3 P. M. never exceeded 81 and not infrequently fell to 30 or less; once as low as 27. The average relative humidity at 3 P. M., for the three months in question, was 55. The average velocity of the wind in summer at 3 P. M. was about 9 km per hour.

It should be remembered in discussing the conditions of existence of plants during hot and dry periods that they are often exposed to the full heat of the sun, and therefore to a very different temperature from the recorded maximum of a meteorological observatory. Observations on the northwestern slope of Monte Solaro, Capri, at about 350^{m} above sea level gave a temperature in the shade August 20 of 31.6° C., at 2 P. M. Burying the bulb of the thermometer a centimeter or two in the soil, in full sunshine, gave a temperature of 50.5°, and placing the bulb of the instrument on the surface of the ground and covering it with dry grass, to exclude the direct rays of the sun, gave a reading of 52.2°. Other days during the same month gave a temperature, as recorded at the neighboring observatory, over three degrees higher than that of August 20, so that the surface temperature, in sunshine, must have been at times as high as 55° C., with a relative humidity as low as 29. This extreme heat is sufficient to demand elaborate protection to prevent excessive transpiration; it approaches the temperature (50° to 60°) of desert soil at midday in summer reported by Volkens.[3] Examination near the locality above mentioned showed during early September an entire lack of sensible moisture, *i. e.*, moisture evident to the eye or the touch, to a depth of from 1 to 2^{m}.

Some data in regard to temperature and rainfall, as recorded at the Royal Observatory of Capodimonte, Naples, are given in the little table subjoined. It is noticeable that the mean of

1902	Mean value of maximum daily temperatures (° C.)	Mean values of minimum daily temperatures (° C.)	Mean value of daily humidity at 3 P. M. (per cent.)	Total rainfall (millimeters)	Means of maximum daily temperatures for thirty-five years (° C.)	Mean rainfall for thirty-five years (millimeters)
May	18.35	11.42	55.3	80.2	21.70	53.42
June	23.99	16.59	55.0	8.0	25.41	31.64
July	28.73	20.50	53.8	0.0	28.53	19.12
August	28.66	20.29	53.8	9.0	28.34	23.88

[3] GEORGE VOLKENS, Flora der ægyptisch-arabischen Wüste 23. Berlin, 1887.

maxima of daily temperatures is a little higher, the mean daily humidity a trifle lower, and the rainfall notably more than at Capri. On the mainland in general the temperatures would run somewhat higher and the humidity lower than at Capodimonte.

The total rainfall for the year at Capodimonte (average of 35 years) is 865.5^{mm}.[1] In an average winter there are only two days in which the temperature falls below 0° C.

The plants which constitute the macchie of the territory under discussion show their xerophytic character more by their mechanisms for the prevention of transpiration than by their provisions for absorbing water or for storing it in large quantities. The most notable succulent plants found in the Neapolitan region are two introduced species, *Agave americana* L., and *Opuntia Ficus-indica* Mill., neither of which occurs as a member of the plant societies here treated. The root systems of most of the plants which constitute macchie are extensive and in the case of many of the species examined by the writer contained more tissue than the stems. The most notably developed roots examined were those of *Daphne Gnidium*. This occurs as an undershrub, with slender clustered stems, usually less than a meter in height. In one specimen examined the average height of the stems was 70^{cm} and the total length of the tap root and its immediate branches was 490^{cm}, with a diameter at the crown of 7^{cm}. The leafy stems together weighed 190^{gm}, while the root system (not quite all secured) weighed 3,030^{gm}. The roots evidently contained much water, and this accounts for the fact that the Daphne, after four months of rainless, hot weather, showed perhaps less signs of distress than any other member of the plant society to which it belonged except Thymelaea.

It has seemed to the writer best worth while to devote his attention mainly to the discussion of the various hindrances to transpiration which present themselves in the most evidently well-equipped of the xerophytic shrubs and undershrubs already enumerated. These adaptations may perhaps best be exhibited in some such table as the following:

MEANS OF PROTECTION AGAINST EXCESSIVE TRANSPIRATION.

	Leaflessness	Leaves (or cladodes) more or less vertical	Acicular or subulate leaves	Minute leaves	Leaves deciduous in summer	Leaves rolling up or withering	Leaves permanently concave, revolute or sulcate	Leaves with glossy epidermis	Leaves coriaceous	Leaves hairy or sericeous	Leaves aromatic	Leaves varnished	Stomata sunken in pits or furrows	Epidermal cells liquefied	Containing stored water or mucilage	Upper epidermis destitute of stomata
1. Ruscus aculeatus L.	×	×											×		×	
2. Asparagus acutifolius L.	×												×			
3. Pinus halepensis Mill.			×											×		
4. Erica arborea L.			×													
5. Ulex europaeus L.			×													
6. Euphorbia dendroides L.					×											×
7. Euphorbia spinosa L.				×												
8. Thymelaea hirsuta Endl.		×		×			×	×	×	×					×	
9. Calycotome villosa Link.					×					×						×
10. Spartium junceum L.				×	×					×			×			×
11. Anthyllis Barba-Jovis L.				×			×			×						×
12. Coronilla Emerus L.					×	×										×
13. Cistus villosus L.					×	×				×						×
14. Cistus salvifolius L.					×	×	×									×
15. Cistus monspeliensis L.							×				×	×				
16. Inula viscosa Ait.						×					×	×				
17. Myrtus communis L.								×	×		×					×
18. Rosmarinus officinalis L.							×		×		×					×
19. Daphne Gnidium L.		×						×	×	×						×
20. Pistacia Lentiscus L.								×	×	×						×
21. Arbutus Unedo L.								×	×	×						×
22. Smilax aspera L.								×	×	×						×
23. Rhamnus Alaternus L.								×	×	×						×
24. Lonicera implexa Ait.								×	×	×						×
25. Ceratonia Siliqua L.								×	×	×					×	
26. Phillyrea variabilis Timb. & Lor.									×	×						×
27. Quercus Ilex L.									×	×				×		
28. Quercus Aegilops L.									×	×						×
29. Quercus Cerris L.									×	×						×
30. Quercus pubescens Willd.									×	×						×
31. Clematis Flammula L.									×	×						×
32. Cytisus spinescens Sieb. var. ramosissimus Ten.				×						×						×
33. Cytisus triflorus L'Her.										×						
34. Cytisus monspessulanus L.										×						
35. Cystisus hirsutus L.										×						
36. Rubus discolor W. & N.																×

The characteristics which belong to each species are checked in the horizontal line on which the name of the species occurs.

It is evident at a glance that a majority of these plants have more than one adaptation each to prevent too rapid transpiration. *Thymelaea hirsuta*, which is protected in the greatest number of ways, is notable as being equally at home on parched mountain sides and in the somewhat saline, almost waterless, sands of Mediterranean beaches, above the reach of ordinary waves. Six species are set down as deciduous in summer, but they are not all equally so. The most notable of these are *Spartium junceum* and *Euphorbia dendroides*. The former generally loses all its leaves early in the dry season and does not usually acquire new ones until the following February, while the *Euphorbia*, when in fairly good soil, retains all, or nearly all, of its immense number of leaves (much like those of *E. Cyparissias* L. of the northeastern United States, only on a larger scale). But in the scantiest soil, or when found growing in the crevices of sunny cliffs, *E. dendroides* appears in summer as a rather succulent, absolutely leafless, much-branched undershrub of a meter or less in height. The economy in transpiration, due to the leafless summer condition of the plant, may be appreciated from the results of a rough experiment. A leafy twig, cut on August 29, 8^{cm} long, bore 86 leaves, of an area varying from $9^{sq\ cm}$ each for the older leaves to about $0.25^{sq\ cm}$ each for the youngest ones. The cut end of this twig was sealed with grafting wax, the cut end of a leafless twig was similarly sealed, then both were weighed and left for 48^{hrs} freely exposed to the air and sunshine. On reweighing, the leafless twig was found to have lost 5 per cent. of its weight and the leafy one 23 per cent.

The large number of plants in these macchie which owe their tolerance of extreme drought to a glossy reflecting leaf epidermis (and usually also to the coriaceous texture of the leaves) is a noteworthy fact. Various species of the same genus are often protected against excessive transpiration in very different degrees. For instance *Quercus Ilex*, *Q. Aegilops*, *Q. Cerris*, and *Q. pubescens* constitute a series of decreasingly xerophytic character. The first has small, extremely coriaceous leaves, with a felt-like

pubescence beneath; the second has larger leaves, which are very coriaceous, and beneath are stellate hairy; the third has larger leaves which are less coriaceous and only moderately pubescent, while the fourth has leaves equally coriaceous with those of *Q. Cerris*, but hardly at all pubescent except when young.

As is often the case in other plant societies, some genera of the macchie show various modes of adaptation to their conditions of life in the several species which represent them. For instance, *Euphorbia dendroides* is protected from dessication mainly by its summer-deciduous habit, while *E. spinosa* is rendered secure by the meagerness of its foliage and the spiny character of its densely clustered branches. *Cistus villosus* and *C. salvifolius* have pubescent leaves, which roll up somewhat or even wither or fall during the season of extreme drought, while the narrow, revolute-margined, somewhat aromatic, viscid leaves of *C. monspeliensis* suffer little or no change even in the driest weather.

The species numbered 20–28 in the preceding table are (with the exception of no. 24) typical members of the sclerophyll society which Schimper describes[4] as the Mediterranean *Hartlaubflora*. As broad-leaved evergreens, they form a conspicuous feature of every wooded landscape, and the dark green color and glossy surface of the leaves of such shrubs and trees as the Pistacia, the Arbutus, the Rhamnus, and the Ceratonia make them highly ornamental. The coriaceous quality of these leaves is of service, as pointed out by Beck (*op. cit.*, p. 116) in withstanding the severe lashings which they undergo from the frequent winter rain and wind storms of the Mediterranean coast, and, as suggested by Kerner in his *Oesterreich-Ungarns Pflanzenwelt* 190, in enduring occasional frosts. In this latter respect some species are not much inferior to the evergreen species of Rhododendron of the eastern United States.

It has been impossible for the writer to secure suitable laboratory facilities for the detailed study of the leaves of the trees and shrubs discussed in the present paper, at times when he could avail himself of them. Many species have been fully

[4] Pflanzengeographie. Jena 1898. Pp. 547–55.

investigated by competent hands, but others which have not will repay thorough study. Only a few notes are here offered.

Most of the evergreen sclerophyll species examined have a thick, apparently structureless cutinized layer overlying the cells of the upper epidermis. In *Rosmarinus officinalis*, *Pistacia Lentiscus*, *Smilax aspera*, and *Quercus Ilex*, this layer is especially well developed. In the species of the macchie generally the upper epidermis is destitute of stomata. Those checked as thus characterized in the table (p. 419) do not by any means exhaust the list, since the leaves of many species were not readily available to the writer for examination. *Olea europea*, *Colutea arborescens*, and *Viburnum Tinus*, occasional members of the Neapolitan macchie, are all destitute of stomata in the upper epidermis. On the other hand, *Inula viscosa* has many, but its leaves wither in the hottest weather, and they are somewhat protected by a varnish-like covering. *Spartium junceum* also possesses very small stomata in the epidermis of the upper surface of the leaf, but the leaves are few in number, small, and deciduous in summer. *Convolvulus Cneorum*, an undershrub of rare or local occurrence, has many stomata in the upper leaf surface, but these are protected by a dense layer of closely appressed long silky hairs. The case of *Thymelaea hirsuta* is particularly interesting. It has already been mentioned as an extremely xerophilous plant, and the histology of its leaves throws much light on its power to regulate transpiration. The leaves are numerous, about 5^{mm} long by 3^{mm} wide, somewhat appressed to the branchlets, with the outer surface smooth and shining, the inner surface concave and densely covered with a short, kinky, white pubescence. The branches droop, so that the outer leaf surfaces, which are morphologically the lower or distal ones, are geocentrically the upper surfaces. These contain no stomata, but the concave, pubescent inner surfaces are provided with stomata. The outer epidermis is covered with a cuticular layer, lined with hemispherical cells of a pale yellowish color, apparently containing water stored in the form of a thin mucilage. The next layer is of larger cells, which appear to contain nearly pure water. The mesophyll, which constitutes the main bulk of the leaf, is loose, with no well-differentiated layers of tissue.

Perhaps it would not be easy to sum up the characteristics of the histology of the leaves of most of the species which constitute the macchie better than by referring to a paper by W. Russell.[5] He has made a careful comparison of the structure, especially of the stems and foliage, of fifty-eight species of plants, taking specimens of each from the neighborhood of Paris and also from Carnoules, on the French Mediterranean coast. Working out the histology of these, with reference to the influence of the Mediterranean climate on structure, he has (among other differences) established the following regards in which the southern differ from the northern forms: Epidermis with larger and higher cells, with more regular contours and thicker walls; more intense lignification; increase of volume of wood and of bast; increase of thickness of leaves.

Generally speaking, these differences between Mediterranean and more northerly individuals of the same species are similar to those which distinguish the Mediterranean from more northerly species of the same genus. This is well shown by comparing, for instance, the Neapolitan species of *Smilax*, *Quercus*, *Rhamnus*, *Rubus*, *Rosa*, and *Viburnum* with those of northern Europe or the northern United States.

NAPLES, ITALY.

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BRIEFER ARTICLES.

A MINNESOTA SPECIES OF TUBER.

(WITH THREE FIGURES)

THE Tuberaceae, which occur abundantly in Europe, have as yet been but sparingly reported from North America. In Saccardo's Sylloge[1] *Tuber macrosporum* Vittad. is reported from Pennsylvania. No authority is cited, and it has been impossible to find the original report. *Terfezia leonis* Tul., a member of the closely allied order Elaphomycetaceae, is reported by Rev. A. B. Langlois[2] from northwestern Louisiana, and has been distributed by Ellis in his *North American Fungi*.[3] Dr. R. Thaxter reports to me that *Tuber dryophilum* Tul. is common in parts of New England, and that other tuberaceous fungi occur there, though not in abundance. The only other report of the occurrence of tuberaceous fungi in North America is from California, where Harkness[4] has found a large number of species of Tuberaceae, including thirteen species of the genus Tuber, seven of which he describes as new.

In view of these facts the occurrence of a species of Tuber in the interior of the continent, and in the most northern part of the United States, is of more than ordinary interest.

On March 11, 1903, specimens of a species of Tuber were collected by Mr. H. L. Lyon in the vicinity of Minneapolis, Minn. The locality where the fungi were found is a steep bank with southern exposure. The soil is a stiff calcareous clay, covered with a shallow layer of leaf-mold. At the time of collection a week of warm weather had melted the winter's snow and thawed the soil to the depth of several inches, but the clay subsoil was still frozen hard, and the surface soil had been soft for only a very few days.

The fungi were found in the leaf-mold about the base of a small group of basswood trees (*Tilia americana* L.). A further collection was

[1] SACCARDO, P. A., Sylloge Fungorum 8: 887.

[2] Journal of Mycology 3: 10. 1887.

[3] ELLIS, J. B., and EVERHART, B. M., North American Fungi, second series, no. 1782.

[4] HARKNESS, H. W., California hypogaeous fungi. Proc. Cali. Acad. Sci. 8 Jy. 1899.

made two days later from the same locality, and in all about thirty specimens of the fungus were obtained. Search has been made under other trees in the same vicinity and elsewhere, but as yet no further localities have been found.

All the fungi collected were in a mature condition. There had hardly been time for their development this spring, though such forms as *Sarcoscypha coccinea* Jacq. had already made their appearance. It

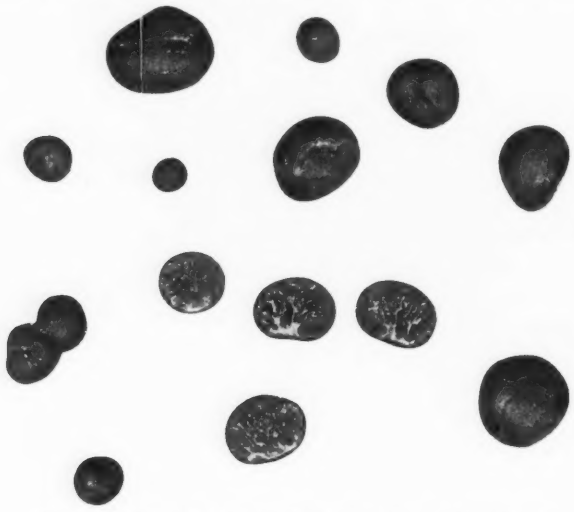

FIG. 1.—Group of the fungi, natural size. From a photograph.

seems probable that the ascomata of the truffle are formed in the late autumn, and lie over the winter in a practically mature state. They probably break down early in the spring. Of a number which were collected and placed in earth out of doors, the greater part are yet (March 26) in a good state of preservation, but though there has been very little warm weather since the date of their collection, and the ground has been covered with snow for a portion of the time, several of them are beginning to show signs of disintegration.

The fungi vary from 0.5–2 cm in diameter (*fig. 1*). The smaller ones are almost spherical, the larger of a somewhat irregular elliptical form. In one case two have evidently grown together during their formation, producing a peculiar dumb-bell shaped body.

Along one side of the fungus runs an irregular scar-like groove

which extends from one fourth to over one half way around the fruit body. In a few specimens this scar is interrupted, and in some it forks or branches somewhat, but it is usually unbranched and continuous. As the fungi lie in their natural position in the soil, this scar maintains no fixed position in relation to the surface of the ground, but is turned in various directions. The surface of the fungus is smooth, slightly pruinose, becoming finally very slightly and minutely areolate. The color is a light chestnut brown, which becomes blackish in spots as the gleba begins to break down. The fungi have a peculiar heavy but not disagreeable odor resembling that of "malted milk."

FIG. 2.—*A*, diagram of a longitudinal section passing through the scar, × 8; *B* detail of a portion of the gleba, × 330. *s*, septa; *v. ex.*, venae externae.

The peridium is rather thin, tough, and cartilaginous, composed of an outer opaque layer and an inner translucent layer. The outer layer of the peridium consists of hyphae having a general radial arrangement, but so closely intertwined as to have almost the appearance of pseudo-parenchyma. Within this is a thin layer of more loosely interwoven hyphae, running for the most part parallel to the surface of the fungus, and within this again a tissue composed of closely packed strands of hyphae running in many directions but all having a general concentric arrangement. The middle layer seen in microscopic preparations is not visible to the naked eye, and may be barely distinguished under the hand lens as a faint line between the outer and the inner peridium.

The gleba is violaceous brown, marbled with numerous veins of two kinds. The venae internae, or septa (*s*, *fig. 2*) are extensions of the inner layer of the peridium into the interior of the fungus. The

removal of the outer layer of the peridium exposes the origin of these septa as a network of numerous anastomosing lines covering all parts of the fungus except that immediately under the scar. In a section of the fungus the septa appear as labyrinthiform anastomosing veins of a dark translucent gray color, appearing in freshly cut specimens darker than the hymenial layer. In specimens preserved in alcohol they become white and are difficult to distinguish from the venae externae.

The venae externae (*v. ex.*, *fig. 2*) appear in a section of the fungus as branching veins of a pure white color, and of a cottony aspect under the hand lens. They alternate with the darker septa, ending blindly toward the periphery, but all communicate with a mass of similar tissue which underlies the scar, and through it communicate with the exterior. This mass of tissue is in places lined with a layer similar to the inner peridial layer, but in other places it abuts directly upon the hymenial tissue. In cases in which the scar is interrupted, the mass of underlying tissue is likewise interrupted, and the venae externae accordingly form more than one group.

The hymenial layer is embraced between these two types of veins. It is of a fleshy but somewhat granular texture, and of a violaceous brown color.

The septa are composed of densely interwoven hyphae having for the most part a radial course, though strands of hyphae running in other directions are not uncommon (*s*, *fig. 2*, *B*). The venae externae (*v. ex.*, *fig. 2*, *B*) consist of more loosely intertwined hyphae. The hymenial layer consists of closely packed asci interspersed with numerous hyphae, and forming no definite palisade layer. The hyphae of the venae externae and of the gleba are very large (4–10 μ in diameter), septate, and sparingly branched. The asci are difficult to see clearly in a section, but may be easily seen in macerated material. They are 1–5-spored, but nearly all of them are 4-spored. The ascus is irregularly elliptical, averaging 45 × 70 μ (p. sp.) and usually is furnished with a long pedicel. *Fig. 3*, *A* shows the most common form of ascus, but irregular asci like that shown in *fig. 3*, *B* and *C* are not uncommon.

The spores are large, elliptical, acutely echinulate, and of a slightly violaceous brown color. Spores occurring in 4-spored asci measure 15–25 × 25–38 μ, averaging 22 × 35 μ. The spores from one-and two-spored asci are larger, in the former case reaching 31 × 48 μ.

As will be seen by this description the fungus belongs to the genus *Tuber* (subgenus *Aschion*), and approaches very close to *Tuber rufum* Pico, and to *T. nitidum* Vittad. in general characteristics and micro-

scopic structure. It is less roughened externally than the typical form of *T. rufum*, and is distinguished from both of the species named by the color of the gleba and spores, by the more conspicuous veins, by the more densely crowded asci, by the slightly larger size and more elongated form of the spores, and apparently also by the greater extent of the scar-like external opening of the venae externae.

Tuber Lyoni n. sp.—Ascomata globose or irregularly elliptical, 0.5–2^{cm} in diameter, having a distinct scar-like groove along one side, smooth,

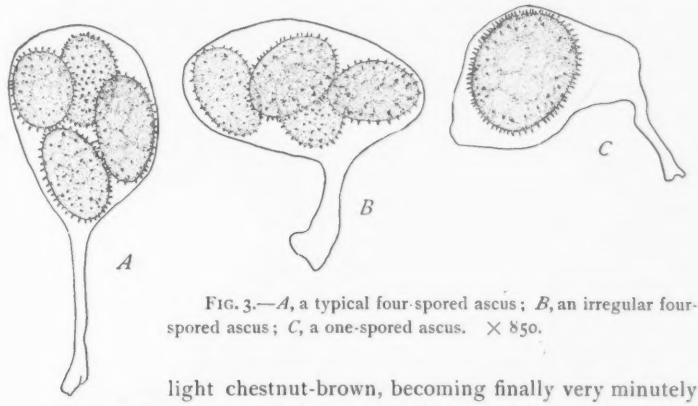

FIG. 3.—*A*, a typical four-spored ascus; *B*, an irregular four-spored ascus; *C*, a one-spored ascus. × 850.

light chestnut-brown, becoming finally very minutely areolate and blackish. Peridium not thick, cartilaginous. Gleba violaceous brown, fleshy but somewhat granular. Septa arising from the peridium, numerous, anastomosing, labyrinthiform, dark translucent. Venae externae white, conspicuous, opening externally throughout the length of the groove. Asci pedicellate, 1–5- mostly 4-spored. Spores elliptical, acutely echinulate, 15–31 × 25–48 μ. Type specimens are deposited in the Herbarium of the University of Minnesota.

The occurrence of this form in Minnesota suggests that it is very possible that this and other species of tuberaceous fungi are not uncommon in the interior of North America. The conditions of their growth render their discovery almost entirely a matter of accident, and in the case of *Tuber Lyoni* the peculiar season at which it occurs may further account for the fact that it has not been hitherto discovered.—FRED K. BUTTERS, *University of Minnesota.*

A NEW BOTANICAL RESEARCH LABORATORY IN THE TROPICS.

In the year 1901 I paid a visit to the colony of Surinam (Dutch Guiana), and as a result of this voyage a scientific laboratory will be opened this year in Paramaribo. A botanist and a chemist will be connected with this laboratory, one of them with the title "agricultural inspector for the Dutch West-Indian colonies." I wish to draw the attention of American botanists to this laboratory, because it will contain a room, 9 by 4.5 meters, where foreign naturalists will have the opportunity for research work.

It is needless to argue here on the advantages of a botanical research laboratory in the tropics; the experience of the botanical garden at Buitenzorg speaks for itself. But for many scientific men in the States Buitenzorg is too far away, and on the other hand there are several problems which can be studied only in tropical America.

For this reason I should like to give here a few more particulars about this laboratory. It will be built in the small experiment garden now existing, which is in great part uncultivated, with an interesting secondary forest. In the vicinity may be found tidal and swamp forests. The large rivers of Surinam are the means of communication with the interior; there is a service of regular steamers on some of them. In the neighborhood of the coast are the European cacao and sugar estates. Bordering the rear of these estates are primeval forests, which cover a great area of the colony; they are perhaps more luxuriant than any in the world. Moreover, the botanist will find large and interesting savannas, and he who can go farther into the interior (the easiest way will be to visit some of the gold fields) may gather many Podostemaceae in the rapids of the upper part of the rivers. Epiphytes (among these especially Bromeliaceae, Orchidaceae, Cactaceae, Ficus), lianes, cauliflorous trees, myrmecophilous trees, Loranthaceae and other parasites—in one word, all the many ecological characteristics of the tropics with their damp climate—may be seen in their highest degree of development here.

Though malarial fever may occur in the interior of Surinam, Paramaribo is almost free from it, and generally speaking it is a healthy town. Yellow fever is almost extinct; since 1867 there has been only one small epidemic, in 1902. From my own experience I feel quite certain that naturalists will be kindly received by the inhabitants and will get a great deal of help from private persons as well as from officials.

Hotels in Paramaribo cannot be said to be very good, though they are not expensive; the average price per day is fl. 5 ($2). In the interior there do not exist hotels or boarding-houses; whoever cannot be the guest of a planter or other European living in the interior will have to carry with him a hammock, tinned food, and other necessities. If we estimate for traveling and other smaller expenses $200, for clothing $100–$150, a four-months stay would cost about $540–$600 plus the steamship fares. There are several direct lines from the United States to Barbados, whence every fortnight a steamer of the Royal Mail Steampacket Company sails for Demerara and Paramaribo in about four or five days. The Dutch mail steamers of the Koninklijke West-Indische Maildienst (Royal Dutch West-Indian Mail Service) sail twice a month from New York via Port-au-Prince, Aux Cayes, Jacmel, Curaçao, Puerto Cabello, La Guayra, Guanta, Cumaná, Carupano, Trinidad, and Demerara to Paramaribo, whence they proceed to Amsterdam. A first-class ticket from New York to Paramaribo costs $100; a return ticket, available for a year, $170. But the company is willing to give a reduction of 15 per cent. on this tariff to every naturalist who goes to Surinam with the aim of studying in the laboratory in Paramaribo. In order to get this reduction one has to make an application (with documents to prove this intention) to the agents of the company at New York (Kunhardt & Co.).

The average temperature at Paramaribo is 27° C. (max. 30–33°, min. 20–22° C.). The big rainy season lasts from the middle of April to the end of February; the dry seasons very often are not so very dry; the total amount of the rainfall is about 2,500 mm yearly. The flowering times are about August, September, October, and from January till April. Whoever intends to make a stay in the new laboratory will have to apply to the agricultural inspector in Paramaribo, whose appointment will be made shortly and will be announced in the botanical journals; moreover, I am willing to give any further information. —F. A. F. C. Went, *University of Utrecht, Holland.*

NEW OR LITTLE-KNOWN WOODY PLANTS.

Crataegus hystricina, n. sp.—A small irregular shrub 9–15 dm high, with several stems from the same root. Bark on the slender stems rough, dark gray, that on the branches smooth and lighter. Twigs stout, red-brown, glabrous, armed with brown-purple thorns 4–6 cm long. Leaves ovate or suborbicular, abruptly acute at apex, rounded or acute

at base, glabrous, with five or six pairs of prominent veins, sharply doubly serrate except at the base; petiole 2 cm long, winged above by the decurrent blade. Flowers appear the first week in June, about 20 mm wide, in ample wide-spreading glabrate or sparingly pubescent corymbs; calyx tube cup-shaped, glabrous, the narrow triangular glabrate acute lobes twice or thrice the length of the tube, deeply glandular serrate, reflexed after anthesis; stamens large, 10, anthers pale violet with darker edges; styles 2–3. Fruit in large drooping clusters, bright scarlet, globose, about 1 cm in diameter, capped by the long spreading or reflexed calyx lobes, ripening in September; seeds generally 3, lateral faces grooved.

Crataegus hystricina has been found only along the rocky bank of the Housatonic river in Southern Connecticut, where it has been collected and studied by *Dr. E. H. Eames*. It is evidently closely related to *C. succulenta*, from which it is well separated by the larger foliage, larger flowers, fewer stamens and different habit.

Amelanchier obovalis, n. sp. *Mespilus Canadensis obovalis* Michx. Fl. 1: 291; *Crataegus Canadensis obovalis* Sarg. Silva 4: 128 in part.—A shrub 9–15 dm high, with numerous erect virgate shoots, or a small tree with short ascending branches attaining a maximum height of about 4.5 m. Leaves elliptic, rounded at both ends, 2–3 cm wide, 3–5 cm long, on unfolding densely tomentose beneath, at length nearly glabrous but pale, finely serrulate or nearly entire; petioles short, pubescent. Flowers appearing from the first to the middle of April when the leaves are less than half grown, in short (3–5 cm long) 5–9-flowered, strict, compact, pubescent racemes; pedicels 2–9 mm long at time of flowering, elongate in fruit, especially the lower ones, which become 2–3 cm long; petals oblong, 6–8 mm long; calyx broadly cup-shaped, the lobes erect or ascending, short and broad, pubescent, greatly enlarging after anthesis and becoming glabrate. Fruit when ripe in June red-purple, subglobose, 7–9 mm in diameter.

This plant is not uncommon along the edges of swamps on loose soils from Smithfield, N. C., southward along the coast to Augusta, Ga., and according to Sargent (Silva 4: 128 seq.) to Mobile, Ala. In leaf form and inflorescence, it is most closely related to *A. spicata* (Lam.) Dec., from which, however, it is well separated.

Amelanchier obovalis was found by the elder Michaux on the coast of Carolina. Torrey later transferred the name to *A. botryapium* and was followed by Sargent, who, while having knowledge of the existence and distribution of the coast plant, confused it with *A. botryapium* and associated both plants under the same name as a variety of *A. canadensis* med.

Crataegus Wilkinsoni, n. sp.—A tree 3–5 [m] high with long horizontal branches forming a flattened crown, trunk armed with numerous long, often compound, thorns. Bark on the scaly trunk gray, that of the branches smoother and lighter. Twigs glabrous, slender, olive or russet, armed with many stout 4–6 [cm] long dark gray thorns. Leaves spatulate, 5–9 [cm] long including the very short petiole, 2–3 [cm] wide, acute or obtuse at apex, gradually tapering into the short grooved winged petiole, glabrous, dark green above, much paler beneath, thin for the group, the 3–5 pairs of prominent veins impressed above, obtusely serrate above the middle, seldom lobed. Flowers about 14 [mm] wide, in large compound many-flowered glabrous corymbs, appearing the first week of June; calyx obconic, glabrous, the narrow entire lobes reflexed after anthesis; stamens about 10, anthers pink; styles 2–3. Fruit in large compound clusters on drooping pedicels, oblong, 16–18 [mm] long, full and rounded at the ends, dull red, capped by the reflexed calyx lobes, ripening early in October, persistent until late in winter; flesh firm, bitterish; seeds generally 2, sometimes 3, deeply grooved on the rounded back.

The species above proposed was collected in both flower and fruit at Mansfield, O., by *E. Wilkinson*, who has permitted me to associate his name with the plant; collected also in fruit by *W. W. Ashe*. It differs from the typical cockspur thorn in the longer, thinner, and more pointed leaves, and deeply impressed veins. It is more closely related to *C. Canybi* Sarg. (Bot. Gaz. 31:3. 1901) which it much resembles in the shape of the leaves, and the impressed veins, and from which it is separated by having longer, stouter thorns, thicker foliage, smaller fruit, and fewer differently colored anthers.

Crataegus habilis, n. sp.— A tree 4–6 [m] high with numerous spreading and ascending branches forming an oval crown. Trunk sparingly armed, its bark scaly, trunk dark gray or brown, that of the branches smoother and lighter. Twigs ascending, glabrous, thick, soft, olivaceous or chestnut-brown, sparingly armed with stout chestnut thorns 3–4 [cm] long. Leaves thin but firm, dark green above, paler beneath, the blades broadly oval, 4–5 [cm] long, 3–4 [cm] wide, abruptly acute at apex, rounded or truncate at base, with 4–6 pairs of shallow notches, sharply but finely serrate, glabrous below on unfolding, pubescent above with short hairs, soon glabrous, fading to lemon yellow and falling late in September or early in October; petiole about 2 [cm] long, slender, nearly terete, grooved above, at first pubescent, soon glabrous. Flowers 16–20 [mm] wide, borne in small 3–4 [cm] wide, nearly simple pubescent cymes, cup-shaped, appearing the second week in May when the leaves

are about half grown; calyx cup-shaped, nearly glabrous, the large triangular glabrate deeply glandular serrate lobes spreading after anthesis; stamens large, generally 5, sometimes 5 to 8 or 10; anthers rose-purple; styles 4–5. Fruit in small 4–6 fruited somewhat compound clusters, on spreading or nodding pedicels, dull scarlet with orange spots at apex, globose, 14–17 mm thick, concave at base, sometimes capped by the large spreading or ascending generally entire lobes, ripening early in September and falling soon after; flesh thick, yellow, juicy; seeds generally 4, somewhat grooved on the rounded back, the lateral faces plane.

The type material was collected at Mansfield, O., by *E. Wilkinson* and *W. W. Ashe* in 1901 and 1902, growing on sunny hillsides with oaks and hickories. *Crataegus habilis* is separated from the other FLABELLATAE having 5 to 10 stamens by the subglobose fruit, small deeply lobed foliage, and small short pediceled corymbs.

Crataegus pentasperma, n. sp.—A tree 4–6 m high with an oval crown and long spreading or pendent branches. Trunk armed with numerous thorns 4–6 cm long, its bark nearly black, broken by shallow furrows or into small scales. Twigs slender, geniculate, at first pubescent, at length glabrate, armed with numerous thorns 3–5 cm long. Leaves firm, bright green and glabrous above, pubescent beneath when young, at length nearly glabrous, except in the axils of the primary veins, the blades 2.5–4 cm long, 1–2 cm wide, obovate or spatulate, obtusely glandular serrate, rounded or acute at apex, often 3–5-notched above the middle, cuneate at the entire base, 1–3 pairs of ascending primary veins; petiole slender, 1–2 cm long, pubescent and roughened with several pairs of dark glands (or the leaves on vigorous shoots nearly orbicular and deeply lobed, with persistent foliaceous stipules). Flowers small, in 5–10-flowered simple or somewhat compound villose corymbs, appearing in the vicinity of Franklin, N. C., the last of May; stamens small, 20; styles 5. Fruit in loose compound or simple clusters, on pendent pubescent pedicels, pyriform, longer than thick, 11–14 mm long, green or green mottled with orange and red, occasionally capped by the stalked reflexed lanceolate villose glandular serrate calyx lobes; flesh thin, very firm and white; cavity small; seeds 5, 6 mm long, smooth or nearly so in the back and faces, attenuate at base. The fruit ripens late in October and falls with the leaves or soon after.

Crataegus pentasperma is separated from the other GLANDULOSAE with 20 stamens, pyriform fruit, and pubescent inflorescence, by the larger, often compound cymes, and 5-seeded green fruit. The type material is from near Franklin, Macon county, N. C.—W. W. ASHE, *Raleigh, N. C.*

CURRENT LITERATURE.

BOOK REVIEWS.

Bacteria.

THE FIRST edition of Fischer's lectures appeared in 1897, and was described by its author as an introduction to general bacteriology, "an endeavor to survey and group into a whole the salient features of the science from the larger biological standpoint." The second edition,[6] just from the press, retains the plan of the earlier volume, although the book has swelled to double its original size, with many additional details and illustrations. The earlier chapters, those on morphology, are among the most valuable, although the author is inclined to believe that the majority of cell variations are the result of degenerative processes, *i.e.*, are involution-forms. In this view he differs from many students who have given special names to the branching forms seen in *B. tuberculosis* and *B. diphtheriae*. In his chapter on "Die Bakterienzelle als osmotisches System," Fischer calls attention to several points in which he departs from his earlier views published in 1900, particularly his explanation of "plasmoptyse"; these changes are based upon new experiments, to be more fully discussed by him in a future publication. It is interesting to note that, in striking contrast to the "immunity"-burdened bacteriological literature of the past two years, this volume devotes nine chapters, or 117 pages, to the carbon and nitrogen cycles, while immunity, vaccination, and serum therapy are disposed of in one chapter of 11 pages. Toward this subject the author seems unsympathetic, and even suspicious; but for a student of morphological, systematic, or agricultural bacteriology the book has much to offer.— MARY HEFFERAN.

Principles of variation.

IN this book Dr. Vernon has assembled with no little skill many important data on the subject of variation and thus supplied a compendium[7] that admirably supplements Darwin's work on *The variation of animals and plants under domestication.*

The subject-matter is arranged under three main parts, viz.: I, The facts of variation; II, The causes of variation; and III, Variation in relation to evolution. In the first part we naturally expect a summary of the results of

[6] FISCHER, ALFRED, Vorlesungen über Bakterien. 2d edition. pp. x + 374. *figs. 69.* Jena: Gustav Fischer. 1903.

[7] VERNON, H. M., Variation in animals and plants. 8vo. pp. 415. New York: Henry Holt & Co., 1903.

biometry and we are not disappointed. However, the author has, wisely enough, avoided an extensive treatment of statistical methods. In the second part, blastogenic variation and those due to the conditions of life are treated in several chapters. In part III, natural selection and adaptive variations are discussed.

The work contrasts favorably with much that has been written on variation and evolution in a semi-popular way, in that the author retains a firm hold on ascertained fact. There is little special pleading in the book, and large generalizations are sparingly attempted; results are impartially presented and their obvious import expressed. On the other hand, the author lacks something of that vigor and enthusiasm that one finds in the champion of a cause; and occasionally there is a lack of that critical and unifying spirit that accompanies complete assimilation of the subject. For example, after reviewing Weldon's paper of 1892, our author approves Weldon's conclusion, based on shrimps, that correlation between two organs is "practically constant" for different localities. On the next page he mentions Pearson's general dissent from this view, without coming to any decision, while nothing is said of Dr. Lee's paper (1901) where the correlation-coefficient between length and height of head is given, for the Ainos as 0.50 and for the German as 0.10, showing an entire absence of constancy.

On the other hand, the treatment of certain subjects is very good. The imperfect fertility of dissimilar races when crossed is well worked out; new data concerning identical twins are given; the theory of regression is clearly explained and many facts quoted as to the effect of external conditions. In discussing adaptation, the author accepts self-adaptation as a factor subsidiary to natural selection. The degeneration of disused organs he finds difficult to account for. He should remember that all "degeneration" is not due to disuse; and that animals with "degenerate" organs, however arisen, can still be adapted if they get into situations where these organs are of no use.—C. B. DAVENPORT.

Two elementary texts.

BOTANICAL texts for the secondary schools multiply apace. Professor Stevens, of the University of Kansas, has published an *Introduction to botany*, which has many good features to commend it.[2] It is an attempt to combine the instruction of the laboratory handbook and the necessary information of the text-book. To secure the proper relations of laboratory work and reading he has introduced the laboratory directions before the discussion of the topic to which they relate. These directions are in the main clear and concise, and the work for which they provide well chosen. A particularly commendable feature is that the experiments in plant physiology are not only

[2] STEVENS, WILLIAM CHASE, Introduction to botany, pp. x + 436, *figs.* 340. Boston: D. C. Heath & Company, 1902.

well selected, but are intermixed with the work on anatomy to which they are related.

Some chapters and sections will doubtless prove very puzzling to beginners, especially those which treat of such difficult subjects as alternation of generations, heterospory, and the fertilization of the egg in angiosperms. The extreme condensation and briefness of treatment will almost defeat the purpose of the author, and we fear will cause these subjects, which ought to be made plain, to be looked upon still as beyond the reach of elementary students. The book is notable for its excellent diagrams, and on the whole is likely to prove its value by use.

Mr. E. F. Andrews,[3] of the Washington, Ga., high school, calls his book *Botany all the year round*, in itself a taking title. In the body of the book he provides ample work to occupy the students through the winter as well as the summer. Each section is preceded by a list of material needed for its study. In connection with the reading matter directions are given for the use of this material, and at the close of the section the student is confronted with a number of "practical questions." The material for study consists chiefly of the flowering plants, only one chapter (of less than forty pages) being devoted to seedless plants and one (of thirteen pages) to ecology. The rest of the book is chiefly concerned with morphology and physiology, the former strongly tinged with the formal morphology of the older school, while the latter is not always accurate, and occasionally distinctly bad. In this part also one finds a good deal of ecology, and the student will likely be confused as to the scope of ecology by the existence of a separate chapter with this label. The practical questions are mostly well calculated to set the student to thinking, but too often they are impossible for him to answer with the data at hand. This tempts him to guess and reason *a priori*, which is directly contrary to the training sought by science work. Not infrequently the author suggests an answer by referring the student to some preceding paragraph, and so cases could easily be cited to show that the asker could not answer his own questions rightly. The book gives one the impression that the author has some familiarity with modern botany, but that he has not yet thoroughly assimilated the facts which he knows. Though the book has much to commend it, it cannot compare in real value with Stevens's and several others which could be named.—C. R. B.

MINOR NOTICES.

Mr. A. S. Hitchcock,[4] assistant agrostologist of the U. S. Department of Agriculture, has published a monograph of the ten North American species of the genus Leptochloa. No new species are described, and some forms

[3] Andrews, E. F., Botany all the year round, pp. 302, *figs. 543*. New York: American Book Company. 1903.

[4] Hitchcock, A. S., North American Species of Leptochloa. U. S. Dept. of Agric., Bureau of Plant Industry. Bull. 33. pp. 24. *pls. 61*. 1903.

kept separate by other authors have been united on the principle that when such forms are connected by numerous intergrading specimens they are to be considered as the same species, although typical specimens of the extreme forms may be easily distinguished.—C. R. B.

A CRITICAL REVISION of the genus Eucalyptus has been undertaken by Mr. J. H. Maiden,[5] the government botanist of New South Wales and director of the Botanic Gardens, Sydney. Part I of this publication has just appeared, containing in the preface a discussion of the variations in the genus, and a list of doubtful species referred to it and such species excluded from the genus, and a bibliography. The remainder of the part is devoted to a description of *Eucalyptus pilularis:* its synonymy, range, and affinities. Of the four plates two are given to the typical form of the species, another to the variety Muelleriana, and one to the illustration of fruits showing variation in the species.

NOTES FOR STUDENTS.

PROFESSOR BOWER[6] has announced the discovery of a sporophyll of *Lycopodium rigidum* bearing two sporangia side by side. The great rarity of this phenomenon emphasizes the remarkable constancy of the solitary sporangium among the true Lycopodiales.—J. M. C.

MOLISCH contends[7] that the buoyancy of the Cyanophyceae of the plankton does not depend upon gas vacuoles, and that the bodies which were so interpreted by von Strodtmann and Klebahn cannot possibly be gaseous. He was not able to determine whether they were fluid or solid, but inclines to the belief that they are viscous.—C. R. B.

HOLM[8] has used a study of *Carex fusca* and *Carex bipartita* as an occasion for severely criticising what he calls "type-species botany." He shows that the superficial determination of herbarium specimens reputed to be the type material of the older taxonomists may be very far from reaching reliable results. He says that such research should include a good deal more, such as a large amount of literary research, a study of the author's method of describing and of citing, the history of the herbarium since it left his hands, etc.—J. M. C.

[5] MAIDEN, J. H., A critical revision of the genus Eucalyptus. pp. 47. *pls. 4.* Published by Authority of the Government of the state of New South Wales. Sydney: W. A. Gullick. 1903. 2 shillings sixpence.

[6] BOWER, F. O., Note on abnormal plurality of sporangia in *Lycopodium rigidum* Gmel. Ann. Botany **17**: 278–280. 1903.

[7] MOLISCH, HANS, Die sogenannten Gasvacuolen und das Schweben gewissen Phycochromaceen. Bot. Zeit. **61**[1]: 47–58. *figs. 4.* 16 Mar. 1903.

[8] HOLM, THEO., Studies in the Cyperaceae. XVIII. On *Carex fusca* and *Carex bipartita* All. Am. Jour. Sci. **15**: 145–152. 1903.

THE CYCADOFILICES, generally recognized as a group intermediate between ferns and cycads, have been known only by their habit and anatomical structure. The discovery of seeds belonging, in all probability, to Lyginodendron[9] lends strong support to the view that the Cycadofilices form the connecting link between ferns and cycads. Botanists must be prepared to find that many of the plants now classed under Cycadofilices possessed seeds and that many of the "fern fronds" of paleobotanists belong to spermatophytes.—CHARLES J. CHAMBERLAIN.

DARWIN AND PERTZ have confirmed their previous results in establishing artificial rhythm in plants[10] through subjecting them to periodically reversed stimulation by means of the intermittent clinostat. Both heliotropic and geotropic stimuli were used, the experiments with light being most successful. Rythmic curvatures were induced for an hour or more in *Phalaris canariensis* by 15-minute reversals of stimulation; the clinostat was then stopped, but the periodic response continued, showing one or two reversals of bending. Alternate unequal stimuli induced persistent unequal curvature.—C. R. B.

THE DEVELOPMENT of lateral members of *Linaria spuria* has been studied by Vöchting.[11] This plant is especially suitable for testing Schwendener's "contact theory," viz., that young organs are laid down in contact with the older, because in *L. spuria* the leaves are in whorls, while the flowers are arranged spirally. Vöchting bases his inferences on the transition region of the stem, and on the anomalies presented by the flowers. He comes to the same conclusion as in an earlier paper on Cactaceae, that the contact theory alone will not account for the position of lateral organs, and falls back on "inner causes" as an explanation of the phenomena observed.—M. A. CHRYSLER.

BLACKMAN[12] has shown that the behavior of germinating teleutospores of Uromyces, Puccinia, and Phragmidium depends upon the amount of water in which the spores are sown. With a thick layer of water, the germ-tube grows until it has exhausted the material of the spore, and then dies, no sporidia being produced. But if the water layer is sufficiently thin for the tube to reach the air before its growth ceases, it immediately produces sporidia in the usual way. When the teleutospores are germinated in moist air

[9] OLIVER, F. W., and SCOTT, D. H., On Lagenostoma Lomaxi, the seed of Lyginodendron. Read before Roy. Soc. London, May 7, 1903.

[10] DARWIN AND PERTZ, On the artificial production of rhythm in plants, with a note on the position of maximum heliotropic stimulation. Annals of Botany **17**: 93–106. 1903. See also *ibid.* **6**: 245. 1892.

[11] VÖCHTING, HERMANN, Ueber den Sprossscheitel der *Linaria spuria*. Jahrb. Wiss. Bot. **38**: 83–118. *pls. 2–3*. 1902.

[12] BLACKMAN, V. H., On the conditions of teleutospore germination and of sporidia formation in the Uredineae. New Phytologist **2**: 10–14. *pl. 1*. 1903.

the sporidia are formed almost immediately "and the promycelium consists of little or nothing more than the characteristic four cells." This phenomenon is probably quite general among the Uredineae, but the sporidia of Ustilago are freely formed under water.—BURTON E. LIVINGSTON.

C. K. SCHNEIDER has recently published an extended account of the native and introduced woody plants of middle Europe in their winter condition.[11] The work was done mostly at Vienna in the Botanic Garden and Hofmuseum, and is preparatory to an extended description of the woody plants of middle Europe. The first sixty-three pages are devoted to a general discussion and contain numerous cuts from photographs, illustrating habit, bark, and method of branching. The second part is a synoptical arrangement of the species, the classification being based upon characters of the buds and twigs. The species are excellently illustrated with line drawings, showing the external characters, and also by a diagrammatic cross-section. It is the most extensive work of this kind we have seen.—A. S. HITCHCOCK.

NEW OBSERVATIONS bearing upon the rôle of water in plants are made by Kurzwelly,[12] who has tested the power to resist poisons which is exhibited by various plant structures, mainly resting forms such as spores, seeds, etc. He finds that resisting power increases as the cells become drier, and that the less the water in the poison used, the longer can the cells withstand it. Thus, antiseptics are less effective in absolute alcohol than in water. This seems to be due to the inability of the solvent to penetrate the protective coverings. Gaseous poisons are more effective than those dissolved in other media than water. We may draw two general conclusions from these results: first, in most cases in order that penetration may occur, water must be present in seed-coats, etc.; and, secondly, the less water there is in the protoplasm, the less susceptible is it to the action of poisons.—BURTON E. LIVINGSTON.

MOLISCH[13] reports as a new discovery the presence of amoebae in Volvox. He has evidently overlooked the work of Hicks, published in 1860, in which a very complete account of "amoeboid bodies" in Volvox is given. According to Molisch the amoeba attacks the coenobium from without by thrusting in a pseudopodium. The number of amoebae varies from ten to thirty in each coenobium. He could not determine whether all the amoebae entered from without. As they were found in the colonies only late in November, Molisch concludes that as the vegetative period nears an end the Volvox cells become less resistant to attacks of the parasite. The account given by Hicks differs from that of Molisch only in interpretation. Hicks did not

[13] Dendrologische Winterstudien. Jena: Gustav Fischer, 1903. pp. viii + 290. figs. 224.

[14] KURZWELLY, WALTHER, Ueber die Widerstandsfähigkeit trockener pflanzlicher Organismen gegen giftige Stoffe. Jahrb. Wiss. Bot. **38**: 291–341. 1902.

[15] MOLISCH, HANS, Amoeben als Parasiten in Volvox. Ber. Deutsch. Bot. Gesell. **21**: 20–23. *pls.* 3. 1903.

believe that amoeba could successfully attack a living cell, and as he found for each amoeba present a cell of the coenobium absent and the amoeba usually occupying the place of the missing cell, he concluded that the cell was transformed into an amoeba. A careful examination of the literature of a subject often changes a discovery into a confirmatory account.—W. J. G. LAND.

BENECKE publishes the following results of experiments on brood-buds of *Lunularia cruciata*.[16] Chemical stimulation is necessary for normal development; no variations of temperature or light will produce normal thalli or rhizoids in pure water; the small amount of mineral water dissolved from certain kinds of glass is sufficient, however. In such very weak solutions light is necessary for the development of rhizoids; one per cent. solutions of certain salts produce them either in light or darkness. Complete nutrient solutions produce large thalli and short rhizoids; lack of nitrates the reverse; lack of phosphates intermediate; lack of potassium a general retardation; lack of calcium stunting, especially of rhizoids; magnesium and sulfates make little difference; surplus iron inhibits growth of rhizoids. The effect upon rhizoids is the resultant between the direct influence upon them and the indirect influence through the thallus. The thallus is smaller and the rhizoids fewer, but usually longer in darkness. Immersed buds show "water-etiolation;" rhizoids in a moist chamber show "air-etiolation;" in solutions poor in nitrates, "etiolation due to nitrogen-hunger." This last idea is supported by experiments of Benecke and others with the rhizoids of *Riccia fluitans* and roots of higher plants.—L. M. SNOW.

CYTOLOGISTS will find in a paper by Häcker[17] an excellent discussion of the individuality of the parental chromatin. After a critical review of the literature, a large part of which has been contributed by himself, the following conclusion is stated: The autonomy of the paternal and maternal halves of the nuclei can be traced in copepods from the fertilized egg through the life cycle to the egg and sperm mother cells. During the maturation of the egg in Cyclops there is a rearrangement of the chromatin elements so that the egg cell contains, in equal measure, elements from the grandfather and grandmother. Connected with this rearrangement is a pairing of the grandfather and grandmother chromosomes. It may be suggested with great probability that this autonomy is of wide, if not general, distribution in plants and animals. The nuclear stages in which the idiomeres (partial nuclei) and gonomeres (double nuclei) appear are closely related. The second part of the paper deals with the nature of fertilization, mixed inheritance, affinity of chromo-

[16] BENECKE, W., Ueber die Keimung der Brutknospen von *Lunularia cruciata*. Bot. Zeit. **61**[1]: 19–46. *figs. 6*. 1903.

[17] HÄCKER, VALENTIN, Ueber das Schicksal der elterlichen und grosselterlichen Kernantheile. Morphologische Beiträge zum Ausbau der Vererbungslehre. Jena. Zeit. Naturwiss. **37**: 297–398. *figs. 16, pls. 1–4*. 1902.

somes, individuality of the chromosomes and morphological organization of the nucleus, and the determination of sex. The theory that the chromosomes are permanent organs dominates the entire philosophical portion of the paper, and the evidence in favor of this theory is ably presented.—CHARLES J. CHAMBERLAIN.

NEWCOMBE[16] has shown conclusively that the so-called thigmotropic responses obtained by Sachs in terrestrial roots were not really such, but merely the effect of injury. The primary roots of seedlings of *Zea mays*, *Pisum sativum*, *Phaseolus vulgaris*, and *Vicia faba* were tested for thigmotropic curvatures with pins, pieces of brass wire, glass needles, and splinters of white oak, yellow and white pine, and tulip wood. None of the species exhibit curvatures with glass or tulip wood and none but Vicia with white pine, but they all curve in the manner described by Sachs when in contact with metal or yellow pine. These observations destroy the only remaining evidence of thigmotropism in terrestrial roots. The phenomenon may be regarded as established, however, for aerial roots. In another paper[17] the same author has shown that in rheotropically curving roots of *Brassica alba*, *Fagopyrum esculentum*, *Helianthus annuus*, and *Zea mays* (white popcorn), the sensory zone extends upward from the tip beyond the region of growth. The same fact was already proved by the same author in case of *Raphanus sativus*.[18] *Brassica alba* shows good rheotropic curves when the root tip is shielded from the water for a distance of 25 mm, although the region of growth extends back from the tip only 5 or 6 mm. The other roots show similar results.—BURTON E. LIVINGSTON.

GERNECK'S[19] experiments with wheat, oats, maize, and cress in various solutions of single and combined salts yielded the following main results. Of the single solutions, several chlorids, potassium phosphate, and water favor the development of stems rather than leaves, while the reverse is true of nitrates and sodium sulfate. Chlorids of the alkaline earths give stronger plants than those of the alkaline metals. $Ca(NO_3)_2$ produces dwarf plants with very hairy leaves and roots. The fewest hairs appear on plants with the strongest leaves. The most chlorophyll occurs in KNO_3 cultures. With complex solutions wheat can endure the addition of 1.5 per cent., cress 1 per cent. and maize 0.5 per cent. NaCl to the nutrient solution. The addition of

[18] NEWCOMBE, F. C., Sachs' angebliche thigmotropische Curven an Wurzeln waren traumatisch. Beih. Bot. Centralbl. **12**: 243–247. 1902.

[19] NEWCOMBE, F. C., The sensory zone of roots. Ann. Bot. **16**: 429–447. *fig.* 1. 1902.

[20] ———, The rheotropism of roots. BOT. GAZ. **33**: 177–198, 263–283 341–362. 1902.

[21] GERNECK, RUDOLPH, Ueber die Bedeutung anorganischer Salze für die Entwicklung und den Bau der höheren Pflanzen. Inaugural-Dissertation. pp. 147. Göttingen: W. F. Kaestner. 1902.

NaCl or the dilution of the nutrient solution produces fewer roots and shoots, narrower and shorter leaves with slower development, stronger thickening of the root elements, and a relative increase in the number of bundles. The presence of NaCl is accompanied by the formation of leaves with fewer air-spaces, and more palisade tissue, chlorophyll, and wax. Dilution of the nutrient solution causes an increase in the length of the roots. Nitrogen-free solutions favor the development of stems. The reader observes in the different cultures a variation of osmotic pressure which does not enter into the author's discussion. This of course makes the results at least questionable. —L. M. SNOW.

A HYBRID COTTON obtained by crossing *Gossypium barbadense* and *G. herbaceum* has been studied by Cannon.[22] The investigations deal with the two mitotic divisions by which the microspore mother cell gives rise to the four microspores. In practically all anthers of the hybrid cotton both normal and abnormal conditions are present. In normal microspore mother cells the first nuclear division is heterotypic, the second homotypic; and the two divisions are the exact homologues of these divisions in pure races of plants. The two sizes of the chromatin rings or loops found in hybrid pigeons and in some pure forms in plants were not found in the hybrid cotton. The behavior of the chromatin at the first division could not be traced with sufficient accuracy to determine whether the two daughter nuclei were of pure or of mixed descent. If the paternal and maternal chromatin is segregated as a result of the two mitoses in the microspore mother cell so as to form nuclei with unisexual chromatin, such an organization of the chromatin would form a morphological basis for variation in accord with the Mendelian laws. Many abnormal cells were observed, but these degenerate before the first division of the microspore mother cell. Amitosis is not rare and is probably a factor which leads to infertility. A few mother cells showed two spindles, as described by other writers on hybrids, but in the hybrid cotton such cells degenerate before the first nuclear division is complete.—CHARLES J. CHAMBERLAIN.

A THIRD REPORT on the marine resources of Hokkaido has been published by the Fishery Bureau of the Hokkaido government, Japan. It is devoted to the Laminariaceae and the Laminaria industries of the island and constitutes a volume of 212 pages illustrated by 41 plates. This is a very important contribution to our knowledge of the kelps, but as it is printed in the Japanese language it must remain somewhat inaccessible to most students. The volume contains three papers: (1) on the Laminariaceae of Hokkaido, by Professor Kingo Miyabé; (2) on the Laminaria industries of Hokkaido, by Shin Yanagawa; and (3) chemical analyses of Laminaria, by Professor Kintaro Oshima. In each of these the material is almost altogether original, and

[22] CANNON, WILLIAM A., Studies in plant hybrids: The spermatogenesis of hybrid cotton. Bull. Torr. Bot. Club **30**: 133–172. *pls. 7–8.* 1903.

the whole constitutes a unique publication of great value. Professor Miyabé considers the outer and inner morphology, propagation, distribution, economic uses, pathology, and classification of the kelps, and describes several new species — eight in Laminaria, three in Alaria, one in Undaria with Dr. Okamura, and establishes a new genus, Kjellmanniella, evidently not very far from Pleurophycus of Setchell and Saunders. Of this two species and one variety are described. The longest of the three articles is the one by Mr. Yanagawa, in which he describes the kelp beds from an economic point of view and discusses the collections, seasons, tools, methods, boats and co-operative agreement among the fishermen. Statistics are given concerning the history of the industry, its total value for the last thirty years, the average annual harvest, the profits of the fishermen, etc. Methods of curing the kelp, prices, government supervision, and a number of other matters of interest are considered, and the trade varieties of kelp are named and described. Professor Kintaro Oshima supplies a brief paper, giving the methods and results of chemical analyses and some notes on organic compounds peculiar to the kelps. The plates are handsome lithographs, quarto size, setting forth the habit of new and important species, figuring the anatomy, and affording views of fishing scenes, tools, warehouses, bales of seaweed and beds of kelp. — CONWAY MACMILLAN.

NEWS.

DR. L. M. UNDERWOOD sailed for Europe on the 6th of June. He intends studying in the larger herbaria during the summer.

THE GOLD MEDAL of the Linnean Society for the current year has been conferred upon the veteran British mycologist, Dr. M. C. Cooke.

MR. SAMUEL M. COULTER, of the Shaw School of Botany, has been promoted from an instructorship to be assistant professor of botany.

MR. HOWARD S. REED, assistant in plant physiology in the University of Michigan, has been appointed instructor in botany at the University of Missouri.—*Science.*

LORIN LOW DAME, a student of the New England flora, especially of the trees of New England, and joint author of several local floras, and an unusually successful director of secondary schools, died on January 27, 1903.

MR. WILLIAM R. MAXON, of the U. S. National Museum, has recently returned from a successful collecting tour with Professor L. M. Underwood, in the Blue Mountain region of Jamaica. He has brought with him a fine collection of ferns.

PROFESSOR ALBERT SCHNEIDER, of the School of Pharmacy of Northwestern University, has been appointed professor of botany, materia medica, and pharmacognosy in the California College of Pharmacy at San Francisco, a department of the University of California. He will begin his duties in July.

MR. GIFFORD PINCHOT, chief of the Bureau of Forestry, has been elected to a professorship in the Forest School of Yale University. He will continue his work and his residence in Washington, but by special arrangement will lecture at Yale. Assistant Professor J. W. Toumey has been advanced to a full professorship in the Forest School.—*Science.*

AT THE annual meeting of the regents of the University of Nebraska on April 24 and 25, Frank G. Miller, of the Yale School of Forestry, was elected professor of forestry, his services to begin September next; Dr. F. E. Clements was promoted from adjunct professor of botany to assistant professor of botany; and H. L. Shantz was appointed an instructor in botany.—*Science.*

WE LEARN from *Gardener's Chronicle* that the new fire-proof herbarium building just outside the Royal Botanical Garden at Kew is completed, and that the plant cases are to be removed at once from the old building while it is being rebuilt and made as nearly fire-proof as possible. The new "wing"

is connected with the original building by corridors on each of the three floors. Until the repairs are fully completed there is likely to be some crowding and inconvenience to both staff and visiting botanists.

THE UNIVERSITY OF CALIFORNIA will offer a special course of twenty lectures on forestry this summer, at Idyllwild, in the main pine belt on San Jacinto Mountain, Riverside county. This resort is situated in the midst of a country rich in forest flora, which is immediately available for illustrations. Dr. Willis L. Jepson, of the department of botany, and Professor Arnold V. Stubenrauch, of the department of agriculture, have been detailed to take charge of the work. It is hoped that Mr. Gifford Pinchot, who is in charge of the U. S. Bureau of Forestry, will give some additional lectures on special topics.

HARVARD UNIVERSITY AND NEW YORK UNIVERSITY unite with the Bermuda Natural History Society in inviting botanists and zoologists to spend six weeks in the temporary biological station provided for the present season at Bermuda. The total expense, including transportation from New York and return, and board and lodging for six weeks at Bermuda, will be $100. The Bermuda Natural History Society has undertaken to provide facilities for collecting, namely, a steam launch, with crew; a sail boat with fish-well and crew; three row boats; and a two-horse carriage capable of carrying ten or twelve persons. The laboratory will be equipped with necessary reagents and utensils except microscopes and dissecting instruments, which should be brought by each investigator. There are two possible dates of sailing from New York; June 20 and July 4. The laboratory will be opened for those who sail on June 20 and will remain open eight weeks, thus providing for those who cannot sail until July 4. Circulars and detailed information will be supplied on application either to Professor C. L. Bristol, University Heights, New York city, or to Professor E. L. Mark, 109 Irving street, Cambridge, Mass.

GENERAL INDEX.

The most important classified entries will be found under Contributors, Journals, Hosts, Personals, and Reviews. New names and names of new genera, species, and varieties are printed in **bold-face type**; synonyms in *italics*.

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